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NATICK/TR-85/026

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TRAY PACK IMPROVED DURABILITY PACKAGING ROUGH HANDLING TEST RESULTS

BY

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The causes of damage to Tray Pack containers during rough handling were determined. Several concepts for increasing the stiffness of the Tray Pack container were developed. Prototypes were fabricated and tested. Shipping containers were tested for their ability to withstand the crushing load resulting from stacking unit loads.

Test results indicated that increasing the base weight of the Tray Pack material, adding reinforcing beads to both top and bottom surfaces, and

making sure that each Tray Pack was thoroughly filled to avoid vacuum stresses resulted in a much more damage-resistant Tray Pack container. Test results also indicated that increases in shipping container rigidity are required so that unit loads can be stacked. Specifically, the shipping containers are to be made smaller so that Tray Packs will fit more snugly inside and bear a portion of the load.

SUMMARY

This report discusses our findings in the development and testing of an improved durability Tray-Pack packaging system.

Our test results indicate that Tray-Pack durability can be measurably improved by taking certain steps immediately. It is recommended that:

1) Tray Packs be made of 90-pound weight material.

2) Tray Packs be filled to maximum full capacity.

3) The inside measurement of Tray-Pack shipping container cartons not exceed 8 5/8" in height and that shipping container liners have line-to-line contact with the shipping container top and bottom.

4) Unit loads be stacked no more than two high.

Our test results indicate that the heavyweight reinforced Tray Pack will survive the rough handling transportation environment without damage. We recommend a further development program to manufacture and test production samples of this design.

Our test results indicate that none of the shipping container concepts tested is capable of withstanding warehouse stacking 4 unit loads high. We recommend a further development program to develop and test a shipping container with the required strength.

PREFACE

Tray Pack Foods, a basic building block of new Combat Field Feeding Systems for the Armed Forces, make possible a totally new concept that takes advantage of new technology to provide the mobility, flexibility, and responsiveness necessary to deliver hot meals almost anywhere on the battlefield.

A review of handling and shipping tests indicated that the durability of the Tray Pack container, however, may be inadequate for field feeding applications. Before Tray Packs can be distributed through the military supply system with assurance that its serviceability will be retained, it is essential that physical damage from rough handling be minimized.

The objective of this contract was to develop an effective and economical means of improving the durability of the Tray Pack containers. An optimum protective packaging design was to be established using predetermined simulated shipping tests and failure analysis.

The contract work covered by this report was performed under Project 1L162724AH99, Joint Services Food System Technology, Task Area BC - Food Packaging, AMAF 81-20(I). The Contract Project Officer was Joseph W. Szczeblowski.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

TRAY PACK IMPROVED DURABILITY PACKAGING

ROUGH HANDLING TEST RESULTS

1. THE TRAY PACK PACKAGING SYSTEM

The Tray Pack

The Tray Pack is a food container that functions as a:

a. food storage vessel
b. food heating vessel
c. food serving vessel

The Tray Pack holds 6 lb. 10 ounces (3 kg) of food. The Tray Pack made by Central States Can Co. is shown in Figure 1.

It has the shape of a rectangular solid being roughly 12" long by 10" wide by 2" deep with a shoulder approximately 1/4" wide all around at the 1½"-height level to accommodate insertion into a steam table heater. The shallow thickness allows rapid and even heating of the food while the large top area allows for easy and convenient serving.

The Tray Pack consists of two parts; the lid or top and the can or bottom. The sides of the Tray Pack are part of the can or bottom.

The top or lid is drawn from 85-pound (0.0094-inch-thick) steel. The lid material has an inner polymeric liner to prevent food contamination and an exterior coating to retard corrosion and oxidation. The lid is nearly flat across its entire surface.

The bottom or can is drawn from 75-pound (0.0083-inch thick) steel. The bottom also has a polymeric inner liner and an outer metal coating. The drawing process on the bottom results in numerous material excesses and these are drawn into a regular pattern by means of vertically oriented indentations and bulges of approximately 0.070" depth around the perimeter of the can. Around the corners these indentations and bulges are sinusoidal in cross

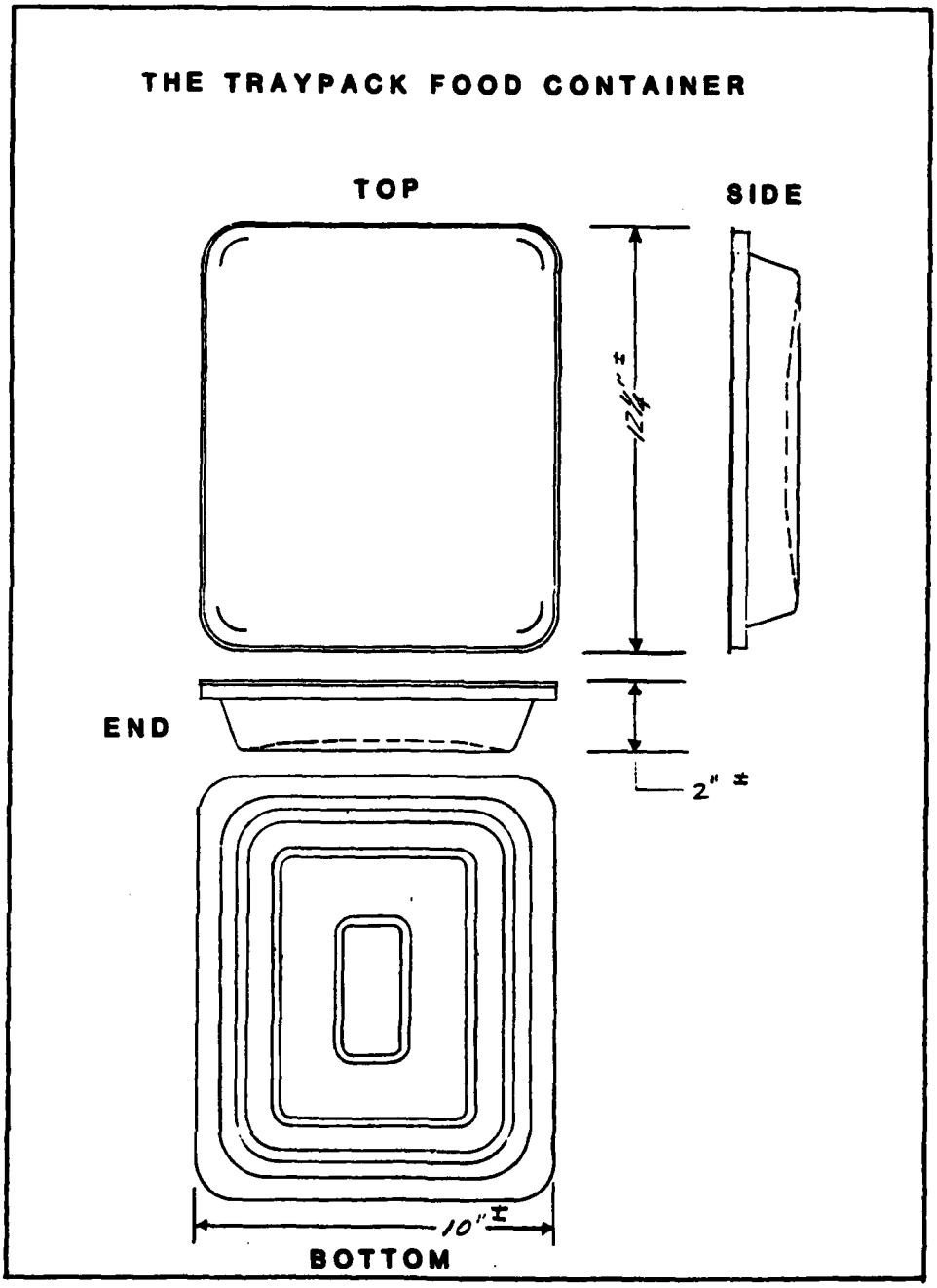


Figure 1. The Tray Pack food container

section but on the sides they have a rectangular cross section.

The material used for making the can and the lid is generically called a "tin mill" product. It comes in coils and is designated either T-4-CA or T-5-CA, which denotes its temper and hardness, T-4-CA (continuously annealed) material having a hardness of 58-64 on the Rockwell 30-T scale and T-5-CA a hardness of 62-68. The T-5-CA material is stiffer and has greater resistance to buckling while the T-4-CA is easier to form. Central States is currently using the T-4-CA material for both the can and the lid. The tensile strength of the material is approximately 60,000 psi.

The shipping container

Tray Pack shipping containers serve a number of functions. First they act as a container allowing the easy manual handling and stacking of multiple Tray Packs. Second, the shipping container materials act to cushion the shock imposed on Tray Packs by rough handling impacts. Third, they act to support the load imposed when Tray Packs are stacked.

Tray Packs are packed four to a shipping container stacked one on top of another to make a handling load of approximately 30 pounds. The dimensions of the shipping container are 13½" long by 11 1/8" wide by 9 3/4" deep. The arrangement of materials within the container is shown in Figure 2.

The shipping container material is V3C fiberboard made by St. Regis Paper Co. The sides of the container are reinforced by means of an inner liner that increases its buckling resistance. A pad is placed on the bottom of the container, between each Tray Pack, and at the top of the container.

The material used for construction of the military shipping containers is designated V3C. This is a single-wall corrugated fiberboard with a minimum bursting strength of 400 psi and a wall thickness of 0.19". One manufacturer of this product is St. Regis Paper Company whose container division is located in Pittsburgh, Pennsylvania.

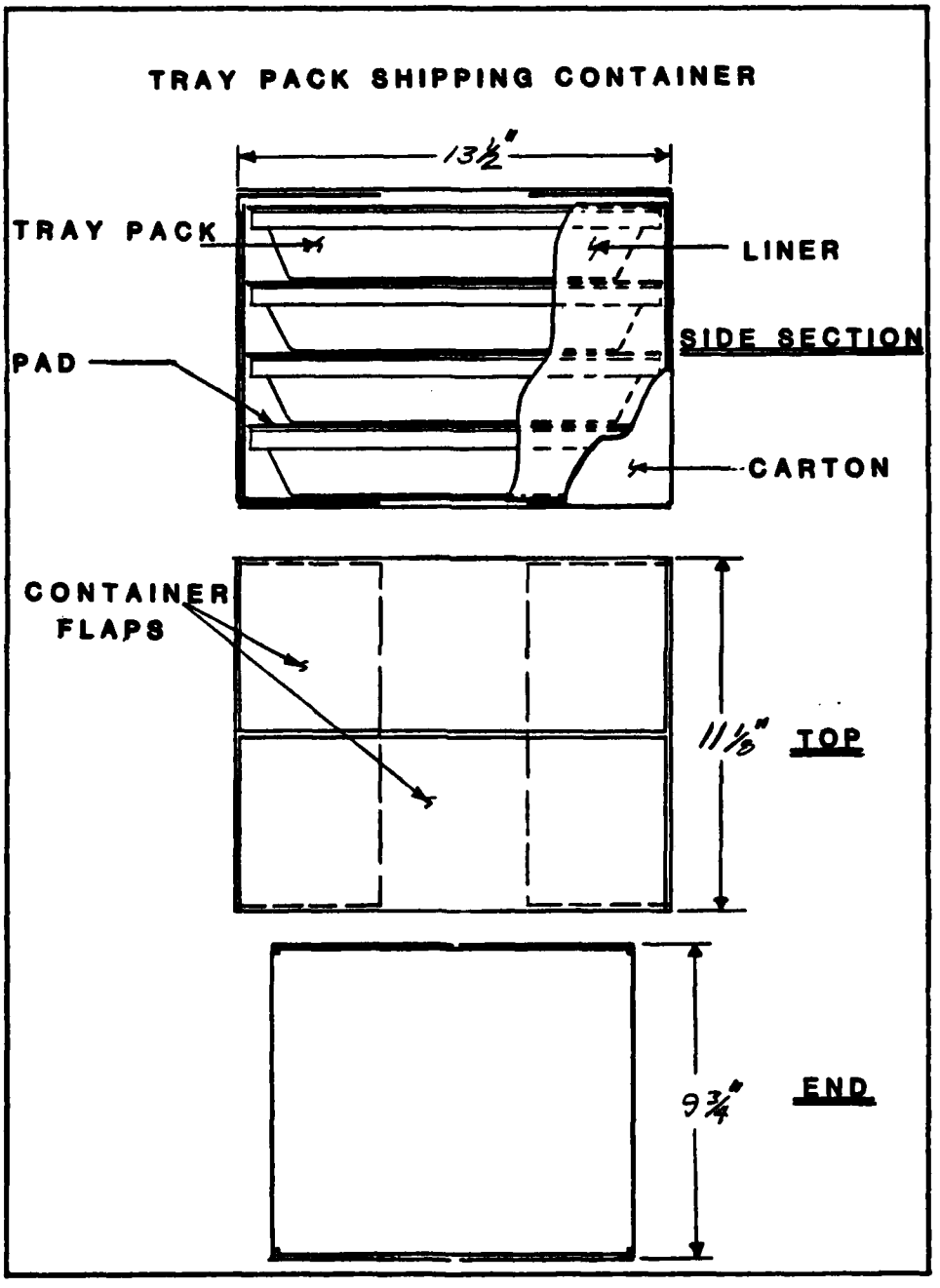


Figure 2. Tray Pack shipping container

The unit load

The shipping containers are packed into unit loads consisting of 48 shipping containers, 12 per layer, 4 layers high atop a pallet. The assembly is covered with a V2s corrugated fiberboard cap and is strapped together as shown in Figure 3.

The assembled weight of the unit load is approximately 1540 lbm. The volume is approximately 48" long by 41" wide by 46" high.

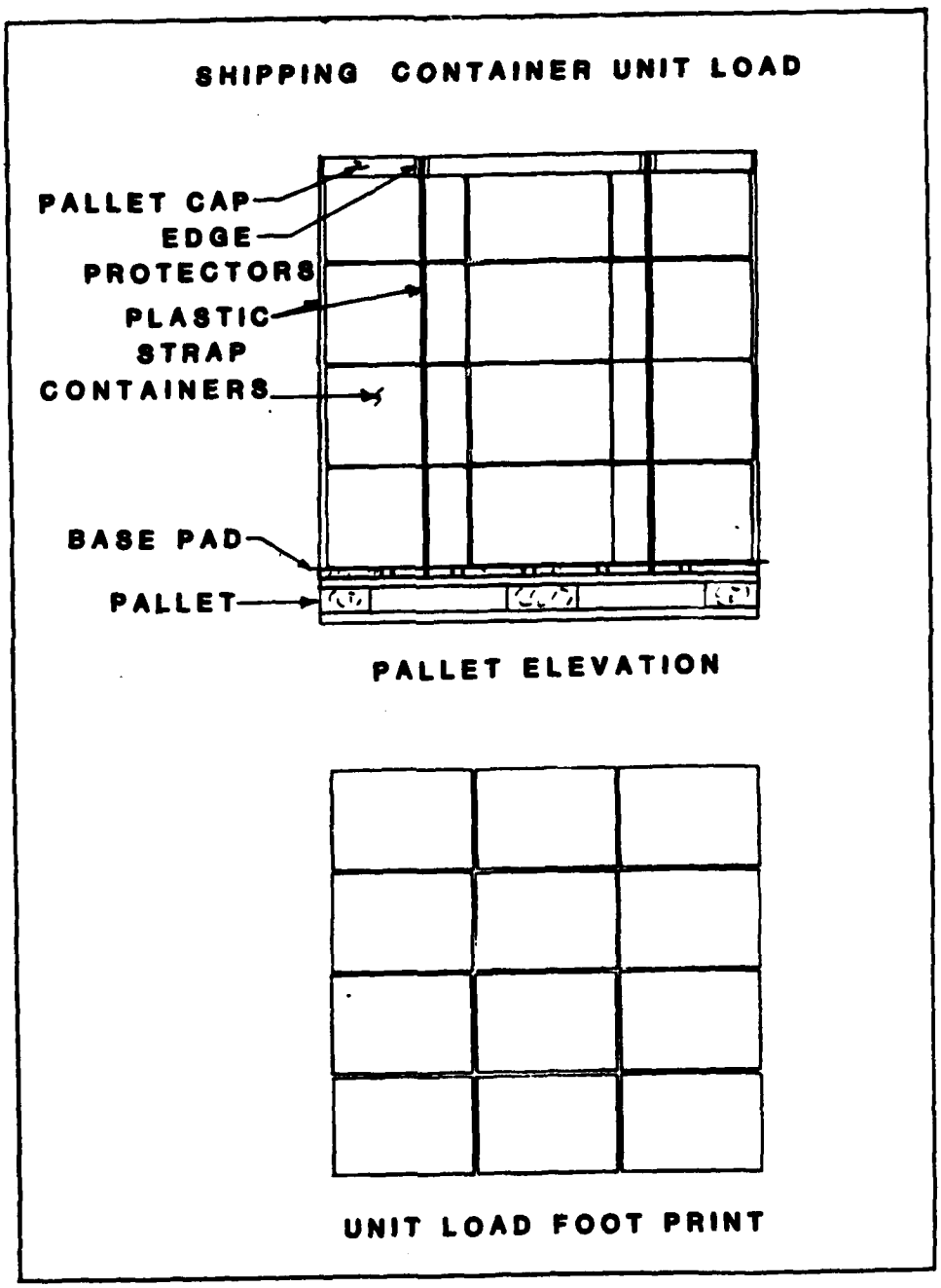


Figure 3. Shipping container unit load

2. TRAY-PACK DAMAGE

Types

Buckling and paneling of the Tray-Pack top (lid) and can bottom surfaces.

Buckling and paneling of the Tray-Pack can sides (or vertical surfaces).

Denting of the Tray-Pack can bottom edges and top and bottom surfaces.

Denting of the double seam.

Note: In can makers' terminology, buckling is an outward deflection of the container material and paneling is an inward deflection of the container material.

Causes

Buckling and paneling of the Tray Pack top and bottom are depicted in Figure 4. The causes of this damage are a combination of the vacuum in the container and the hydrodynamic forces generated by acceleration of the fluid (food) in the container. The vacuum in the container is generated during the food filling and sealing process and is a function of the type of food being packed and the amount of food packed in the container. The hydrodynamic forces generated by acceleration are caused by dropping and side impact of the Tray Pack during manual handling of the Tray Pack and during shipping and handling of Tray Packs in shipping containers and assembling into unit loads.

Buckling and paneling of the Tray Pack sides is caused by hydrodynamic forces within the Tray Pack when the Tray Pack is dropped on its bottom or its side. When the Tray Pack is dropped on its bottom, either inward paneling or outward buckling can occur, depending on the level of vacuum in the container and the amount of top and bottom reinforcement. When the Tray Pack is dropped on its side, outward buckling of the impact side can occur.

We are not exactly sure of the cause of Tray Pack denting. We do know that it is caused during the process of filling and handling in the food packer's plant and that it is caused by impact of the Tray Pack with some relatively pointed object or objects.

Our discovery of denting of the Tray Pack seam was in a carton that showed evidence of having been struck.

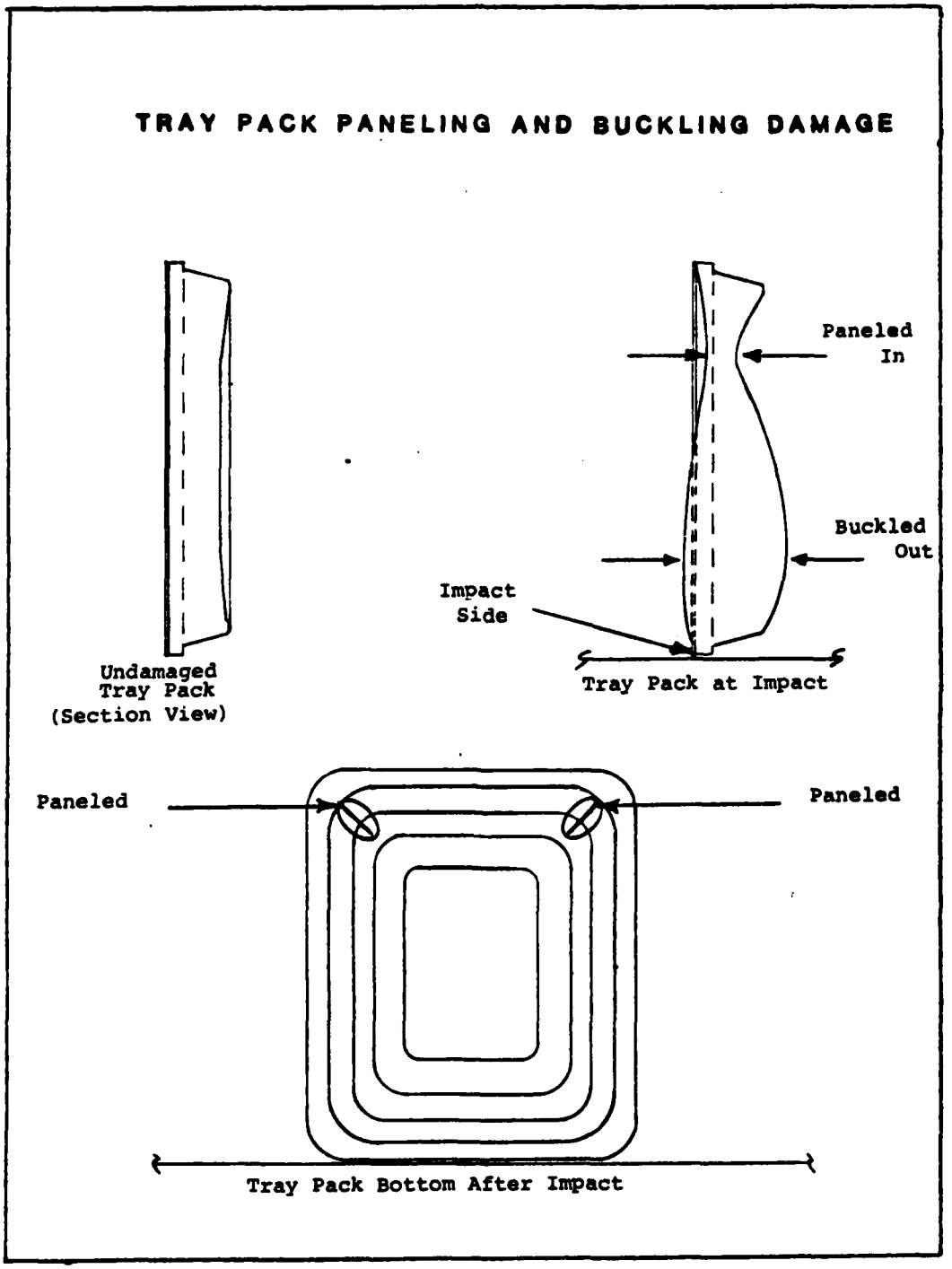


Figure 4. Tray Pack paneling and buckling damage

Shipping container damage

The types of damage to the shipping container found were:

Denting of the sides.
Denting or crushing of the corners.
Buckling of the vertical side walls.
Bulging of the container under compression load.

We found one instance of shipping container side denting during incoming inspection. We suspect that it was due to pressing the unit load against some pointed object such as the corner of a pallet while the unit load was being lowered. Denting or crushing of the corners of the shipping containers was caused during the corner drop test portion of the Acceptance Drop Tests. We did not find this type of damage during incoming inspection.

Buckling of the vertical side walls of the baseline shipping containers occurred during unit load drop tests. These shipping containers were at the bottom of the unit load. It was caused because the liners were ¼" shorter than the containers, preventing the liner from supporting the weight of the shipping containers above. These shipping containers were purchased from the food packer (Vanee).

Bulging of the container during compression load occurred because the shipping container side walls and liner are not strong enough to bear the compression load so that they bulged and shortened transferring the load to the Tray Packs themselves.

3. TRAY PACK ROUGH HANDLING ENVIRONMENTS IN RELATION TO TESTING PROGRAM

Handling scenario

The Tray Pack rough handling scenario is presented in Table 1.

The scenario begins with handling of the Tray Pack within the packing plant. According to ASTM the rough handling environment is dropping of the Tray Pack. But, as discussed previously, we have found evidence of denting of Tray Pack bottom caused by impacting unknown objects such as bench edges, rollers, etc.

The Tray Packs are loaded into shipping containers, and the shipping containers are made into unit loads. The second step in the scenario for rough handling is the dropping of the unit loads while being loaded by fork lift truck into a rail car. However, as discussed previously, we have found one indication that this mode of transportation also includes damage to the shipping containers by dropping the unit load while it is pressed against a protruding object such as the corner of a pallet in the second layer of a unit load stack.

This is followed by vehicle vibration simulating loads on the unit load during shipping.

The next environment is simulating impact of the loads during rail switching.

The loads then become repetitive including warehouse stacking on-truck manual handling, loose load vibration, and off-truck manual handling.

TABLE 1

TRAY PACK ROUGH HANDLING SCENARIO

HANDLING MODE #	CONTAINER	MODE	ROUGH HANDLING ENVIRONMENT	LOAD LEVEL	SPECIFICATION
1	TRAY PACK	MANUAL HANDLING IN PLANT	DROP	BOTTOM - 30" EDGES - 15" CORNERS - 15" TOP - 15"	ASSURANCE LEVEL II ASTM D775 DROP TEST
2	UNIT LOAD	MACHINE HANDLING FOR RAIL TRANSPORT	DROP	PALLET EDGES - 6"	ASSURANCE LEVEL II ASTM D1083 DROP TEST
3	UNIT LOAD	RAIL TRANSPORT	VIBRATION	VERTICAL 3-100 HZ 0.25 g FOR 10 MINUTES	ASSURANCE LEVEL II ASTM D999 METHOD C
4	UNIT LOAD	RAIL SWITCHING	IMPACT $\pm$ 10 ms	6 MPH	ASSURANCE LEVEL II ASTM 880 PROCEDURE C
5	UNIT LOAD	WAREHOUSE STACKING	COMPRESSION 24 HOURS	4620 LB	ARMY STACKING PRACTICE 4 UNIT LOAD HIGH
6	SHIPPING CONTAINER	MANUAL HANDLING ONTO TRUCK	DROP	BOTTOM - 26" EDGES - 13" CORNERS - 13" TOP - 13"	ASSURANCE LEVEL II ASTM D775 DROP TEST
7	SHIPPING CONTAINER	LOOSE LOAD VIBRATION ON TRUCK	VIBRATION	3 - 100 HZ 0.5g 50% Vertical 25% Horizontal 25% Horizontal	ASSURANCE LEVEL II ASTM D999 METHOD C ELEMENT F
8	SHIPPING CONTAINER	MANUAL HANDLING OFF TRUCK	DROP	BOTTOM - 26" EDGES - 13" CORNERS - 13" TOP - 13"	ASSURANCE LEVEL II ASTM D775 DROP TEST

Test plan

The test plan that we evolved was designed to firstly determine the types of damage currently being sustained by the Tray Packs, the types and magnitude of the physical causes of damage, and the ability of various improved durability concepts to sustain the actual rough handling environments.

Incoming inspection

To determine the types of damage currently being sustained by Tray Packs, we conducted incoming inspection on every Tray Pack purchased from commercial packers for this program. By doing this we were able to identify almost every type of damage we encountered in laboratory testing and two types of damage we did not find in the laboratory.

Evaluation testing

The evaluation testing program was designed to determine the types and magnitude of the physical causes of damage. The tests included in this series were:

a. The vacuum test
b. The Tray Pack side drop test
c. The shipping container side drop test
d. The shipping container compression test

Early in our testing we determined that dropping the Tray Pack on its side resulted in paneling and buckling of the Tray Pack bottom and lid. We hypothesized and theorized that this damage was caused by hydrodynamic forces within the Tray Pack fluid applied to the container surfaces; a positive pressure on the lid near the impact side caused buckling and a negative pressure on the bottom opposite the impact side caused paneling.

In order to ascertain the level of pressure required, we formulated the vacuum evaluation test shown in Figure 5. In this test we created a vacuum in the Tray Pack and continued to increase the vacuum level until paneling failure occurred.

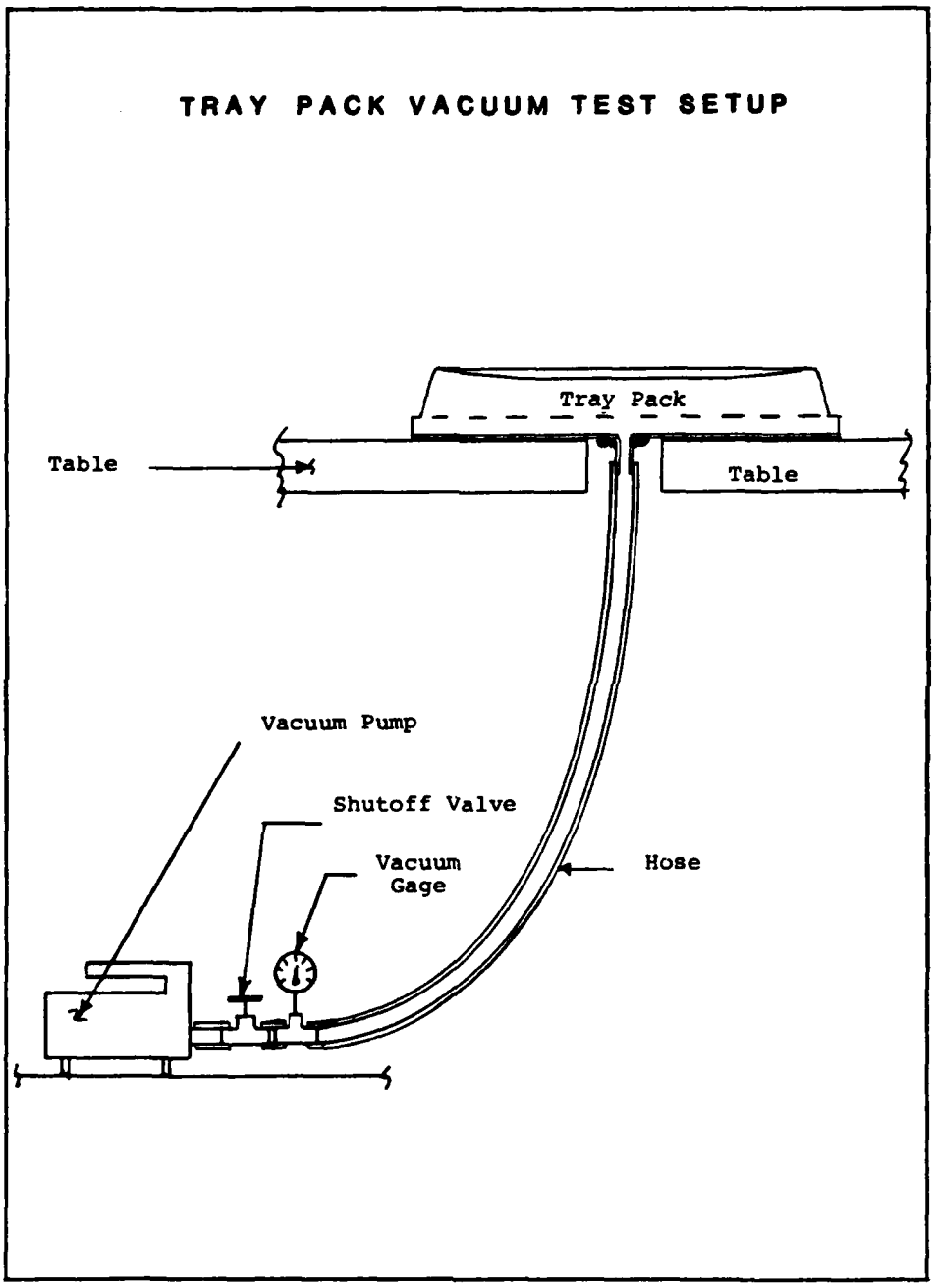


Figure 5. Tray Pack vacuum test setup

We then calculated the equivalent drop height at which the same vacuum would occur.

In order to prove that this calculated drop height was the actual drop height, we took samples filled with air, drilled a hole in the top lid, filled the sample with three liters of water and conducted a test whereby we dropped the sample on its side over and over at successively greater height until the sample failed.

From these tests were formulated the evaluation tests E-1, Vacuum Test and E-2, Side Drop Test. The purpose of the Vacuum Test was so that we could physically observe the failure of various reinforcing concepts as well as the vacuum level at which they occurred.

The purpose of the Side Drop Test was to corroborate the ability of various concepts to withstand without damage a drop from a height measurably exceeding the capability of the current Tray Pack design.

The procedures and depictions of these tests are presented in Tables 2 and 3 and in Figures 5 and 6.

We realized that when Tray Packs packed in shipping containers are dropped, some of the shock is absorbed in the shipping container material rather than by the Tray Pack. Consequently the height of shipping container drop sustainable without damage to the Tray Pack would be different than that resulting from dropping the Tray Pack alone.

Based on this realization we defined a shipping container Side Drop Test. The purpose of the Side Drop Test was to determine the height at which the Tray Packs would sustain damage. The test was to serve as the basis of comparison between concepts for reinforcing the Tray Pack and concepts for enhancing the shock absorbing capabilities of the shipping containers.

The procedure and depiction of this test are shown in Table 4 and Figure 7.

TABLE 2

EVALUATION TEST E-1

TRAY PACK VACUUM TEST PROCEDURE

Test samples shall be Tray Packs of various reinforcement concepts filled with air.

Procedure:

(1) Install sample in test setup.
(2) Turn on pump with isolation valve closed.
(3) Crack isolation valve and apply 1" Hg.
(4) Examine sample for paneling.
(5) If sample has paneled:
    (a) Number and mark sample and record on data sheet.
    (b) Discontinue test and disconnect Tray Pack from equipment.
(6) If sample has not paneled:
    (a) Record result on data sheet.
    (b) Crack valve and increase vacuum by 1" Hg.
(7) Repeat procedure until:
    (a) Failure
    (b) 7" Hg vacuum is reached.

TABLE 3

EVALUATION TEST E-2

TRAY PACK SIDE DROP TEST PROCEDURE

Test samples shall be Tray Packs of various reinforcement concepts filled water and packed foods.

Procedure:

(1) Raise the sample such that the shorter edge is parallel to and 3" above the floor.
(2) Release the sample evenly and allow the sample to drop and its edge to impact the floor.
(3) Examine the sample for paneling.
(4) If sample has paneled:
    (a) Mark and number sample and record results on data sheet.
    (b) Discontinue test.
(5) If sample has not paneled
(6) Raise Sample by 3".
(7) Repeat procedure until:
    (a) Failure
    (b) 21" drop height test is complete.

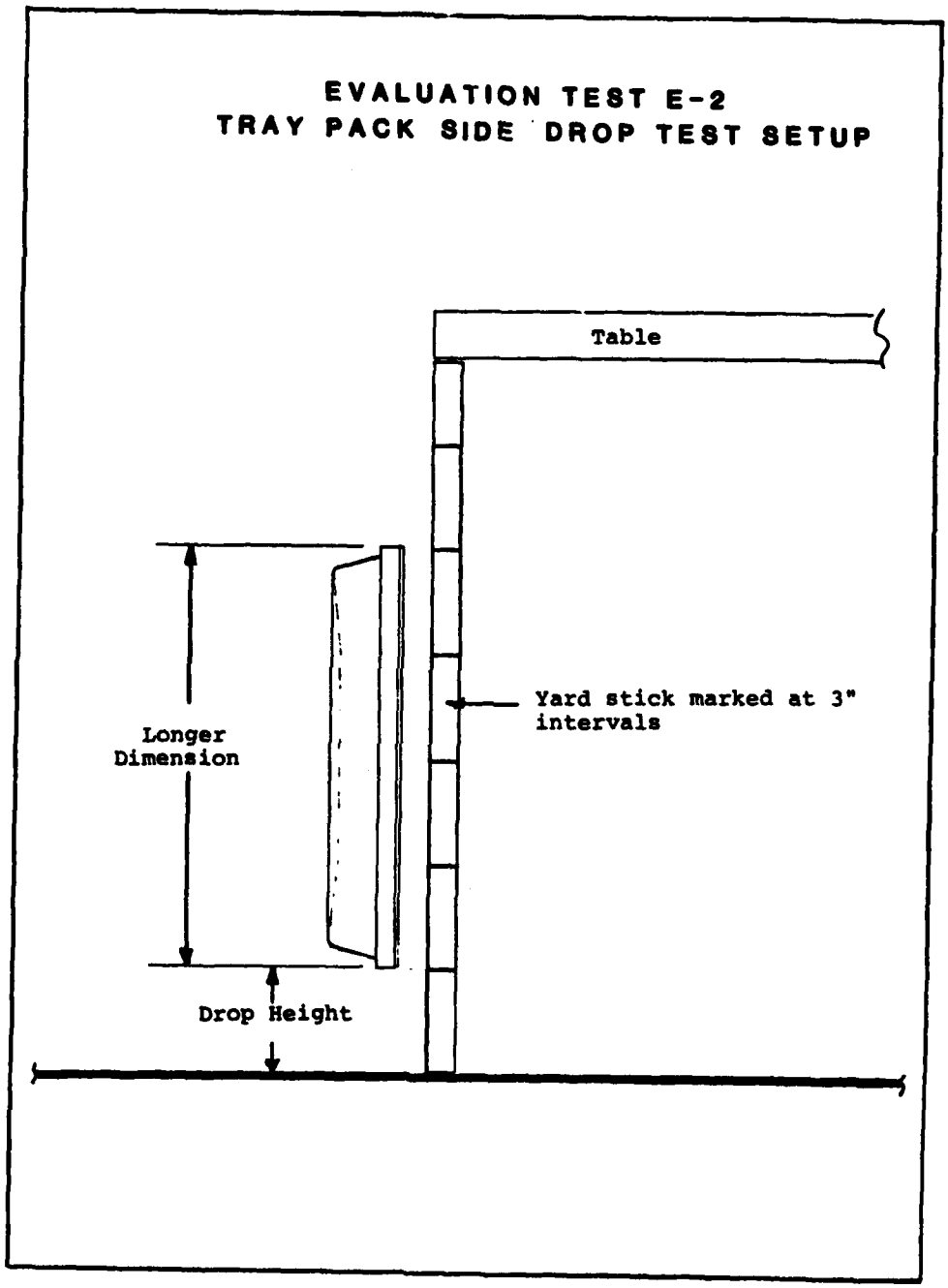


Figure 6. Evaluation test E-2, Tray Pack side drop test setup

TABLE 4

EVALUATION TEST E-3

SHIPPING CONTAINER SIDE DROP TEST PROCEDURE

Test samples shall be shipping containers of various shock absorbing concepts packed with Tray Packs of various reinforcement concepts and filled with water or foods.

Procedure:

1. Install sample in sling with shorter edge parallel to floor.
2. Level sample.
3. Raise to 3" above floor and relevel sample if necessary.
4. Using torch, melt suspension line allowing sample to drop.
5. Carefully unpack the Tray Packs marking the impact edge and marking any damage.
6. Record results on data sheet.
7. If samples have been damaged:
   a. Discontinue Test.
   b. Repack samples.
8. If samples have <u>not</u> been damaged:
   a. Carefully repack samples as before.
   b. Reinstall sample in sling and increase height by 3".
   c. Repeat procedure until testing of 30" height is reached.

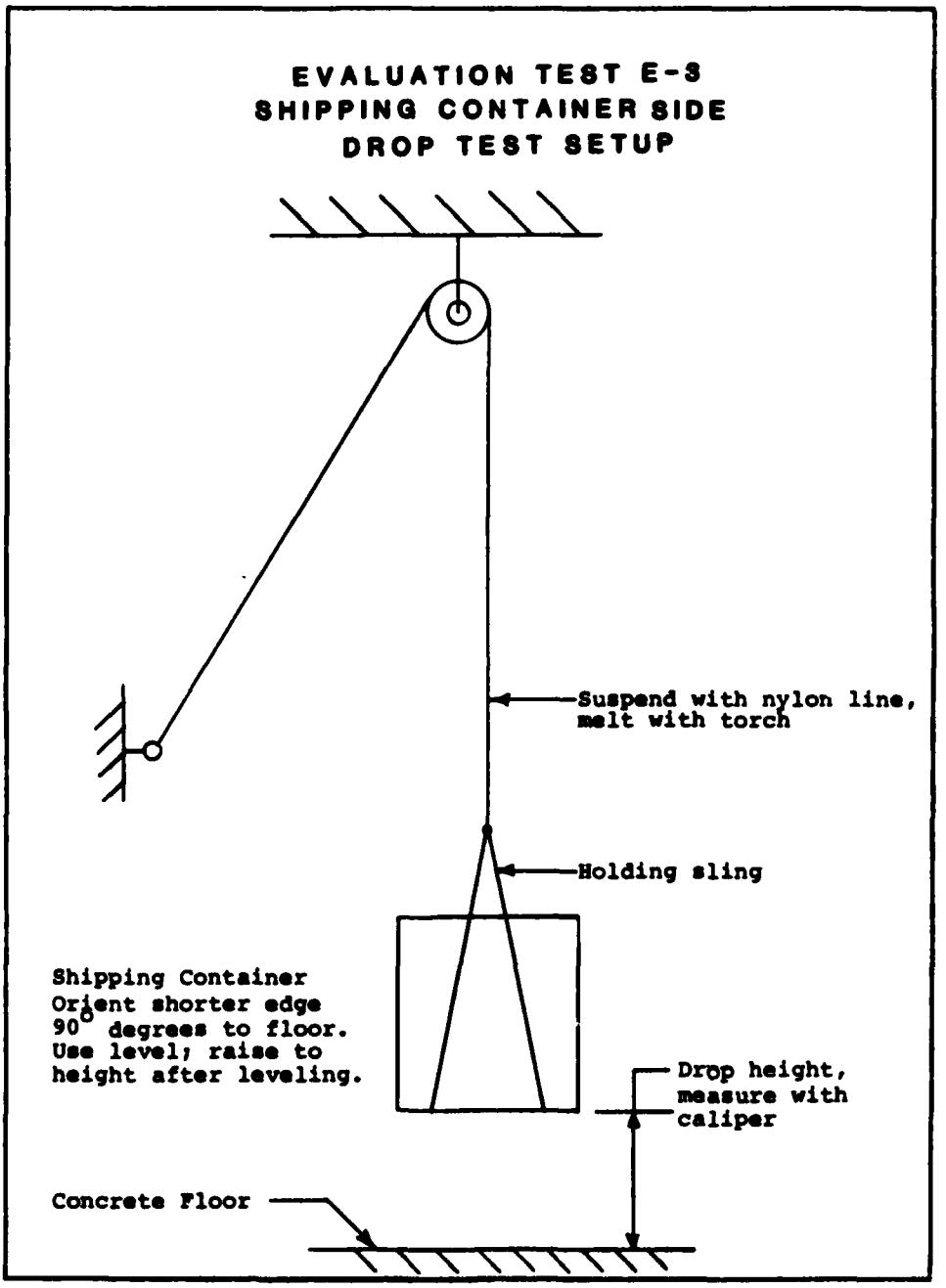


Figure 7. Evaluation test E-3, Shipping container side drop test setup

In considering the potential sources of damage to the Tray-Pack container, we felt that collapse of stacked unit loads in the storage warehouse might be a problem. In order to evaluate this possibility, we devised a test in which we loaded single shipping containers with weight.

From these tests we determined that while the shipping containers easily accepted instantaneous loading of very heavy weights, they collapsed under the same loading over a period of 24 hours. Consequently we revised our Acceptance Tests to reflect long-period rather than instantaneous loading.

The procedure and depiction for the Evaluation Test E-4, entitled Shipping Container Compression Test, are presented in Figure 8 and Table 5.

Acceptance testing

The purpose of the Acceptance Testing program is to determine the capability of the Tray Pack to withstand the rough handling environments as typified by the rough handling scenario of Table 1.

We felt that the ability of the Tray Pack to withstand rough handling within the packer's plant was handled insofar as we are currently capable of handling it by means of Evaluation Test E-2, and so we did not perform an Acceptance Test on the Tray Pack per se.

This is not to say that we feel completely comfortable about the problem of rough handling of the Tray Pack within the packer's plant, but rather that we need a lot more information about how the Tray Packs are processed through the plant to be able to devise an intellignet Acceptance Test Plan for this phase.

The transportation modes include these different rough handling environments:

a. Shipping container dropping
b. Unit load dropping
c. Unit load compression
d. Unit load impact
e. Shipping container loose vibration

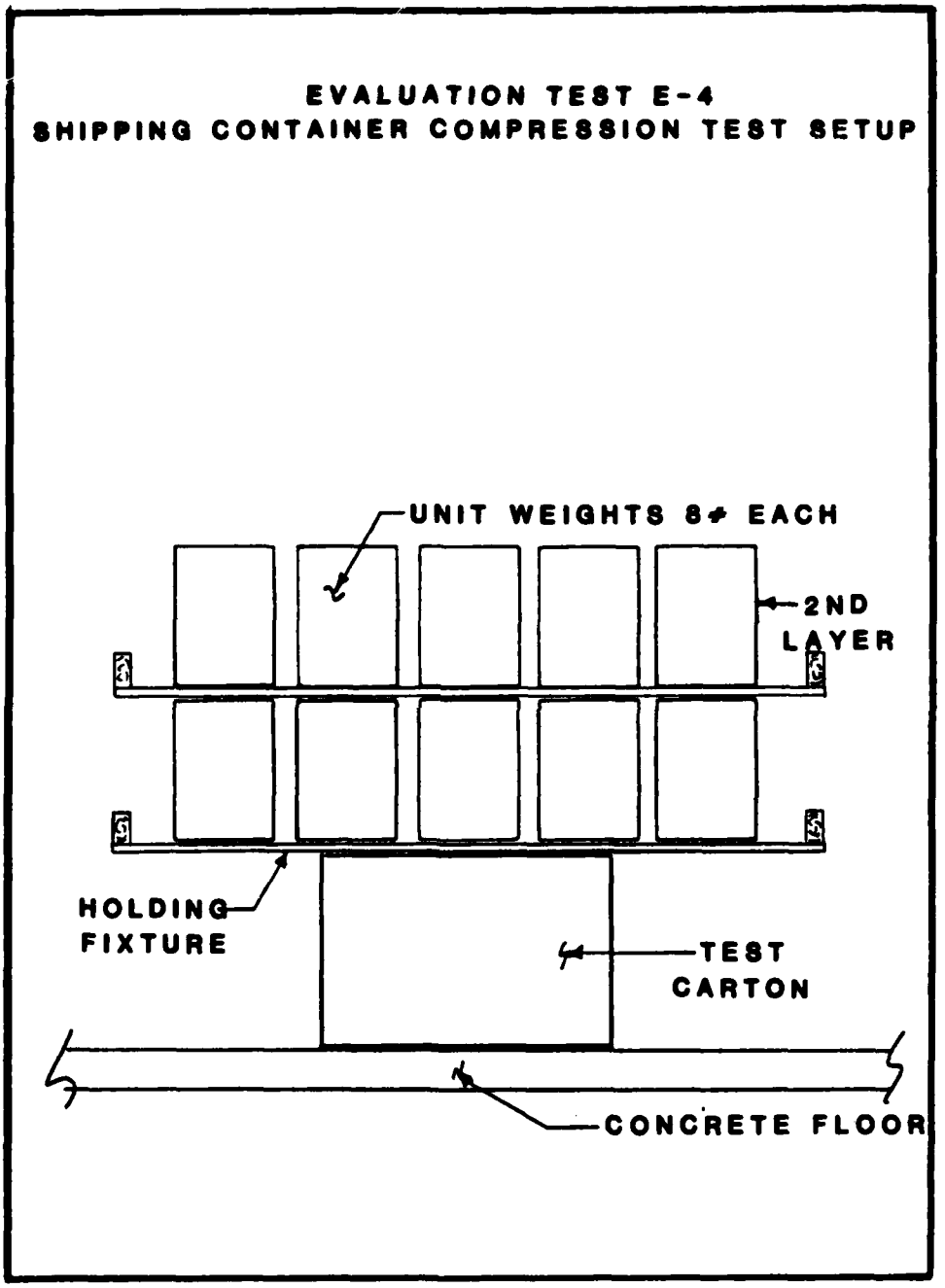


Figure 8. Evaluation test E-4, Shipping container compression test setup

TABLE 5
EVALUATION TEST E-4
SHIPPING CONTAINER COMPRESSION TEST PROCEDURE

Test samples shall be various shock absorbing shipping container configurations including the current configuration.

Procedure:

(1) Place carton on floor.
(2) Place load holding fixture on carton centering it to assure that load will be evenly applied.
(3) Measure height of fixture above floor.
(4) Apply load.
(5) Measure change of height fixture above floor.
(6) Inspect carton for damage.
(7) Leave sample overnight and reinspect the next day, remeasure height.
(8) Increase load and remeasure.
(9) Continue until carton fails.

Our Acceptance Test Plan was developed around the need to subject the Tray Packs to each environment.

The shipping container Drop Test was developed as an extension of the Evaluation Drop Test. The major difference was the construction of two holding fixtures to accurately and repeatably position the shipping containers for edge and corner drops. The procedure and depiction of these tests is shown in Table 6 and Figure 9.

Unit load dropping was quite simple to accomplish and the procedure is presented in Table 7 and depicted in Figure 10.

Unit load compression was an extension of the Shipping Container Compression Test E-4 and is presented in Table 8 and depicted in Figure 11.

Due to a misunderstanding we thought that Acton Environmental Test Laboratories had the equipment for performing an ASTM Railroad Impact Test. In later discussions we found out that they did not and they suggested a Pendulum Test. Upon investigating this test we felt that it could prove to be more expensive than the program could stand.

Consequently, we settled on simulating the Impact by conducting a Side Drop Test from a height of 14.5 inches using two shipping containers as a dummy impact back load. The drop from 14.5 inches would create an impact velocity of 6 mph as required and the two shipping containers would have the same "piling up" effect as they would in the case of lateral impact.

This test is presented in Table 9 and depicted in Figure 12.

The shipping container Loose Vibration Tests were conducted at Acton Laboratories. The shipping container loose vibration procedure and setup are shown in Table 10 and Figure 13.

TABLE 6

ACCEPTANCE TEST A-1

SHIPPING CONTAINER DROP TEST PROCEDURE

Test samples shall contain each candidate Tray-Pack container filled with water, peas, and lasagna and shall be the baseline and bundle concept shipping containers as listed below.

BASELINE CONTAINER

Baseline Tray Pack - water, peas, lasagna
Reinforced Tray Pack - water, peas, lasagna
Heavyweight Tray Pack - water, peas, lasagna
Heavyweight, Reinforced Tray Pack - water, peas, lasagna

BUNDLE CONTAINER

Baseline Tray Pack - water, peas, lasagna
Reinforced Tray Pack - water, peas, lasagna
Heavyweight Tray Pack - water, peas, lasagna
Heavyweight Reinforced Tray Pack - water, peas, lasagna

TEST PROCEDURE

(1) The shipping container shall be dropped in sequence as listed below:

DROP #	IMPACT SURFACE	DROP HEIGHT
1	BOTTOM	26"
2	BOTTOM/#3 SIDE - EDGE	13"
3	BOTTOM/#2 SIDE - EDGE	13"
4	BOTTOM/#2, #3 SIDE - CORNER	13"
5	BOTTOM/#1, #4 SIDE - CORNER	13"
6	TOP	13"
7	BOTTOM/#1, SIDE - EDGE	13"
8	BOTTOM/#4 SIDE - EDGE	13"
9	BOTTOM/#1, #4 SIDE - CORNER	13"
10	BOTTOM/#3, #4 SIDE - CORNER	13"

TABLE 6 (CONTINUED)

ACCEPTANCE TEST A-1

SHIPPING CONTAINER DROP TEST PROCEDURE

(2) The sample shall be placed in the sling and placed in the correct orientation using as applicable:

(a) the level
(b) the edge drop fixture
(c) the corner drop fixture

(3) The sample shall be raised to the required height.

(4) Using torch, melt the nylon cord suspension line allowing the sample to drop.

(5) Note any damage to the shipping container on the data sheet.

(6) Repeat the above procedure until test sequence number 10 is complete.

(7) Remove the Tray Packs from the shipping container. Mark any damage and record same on the data sheet.

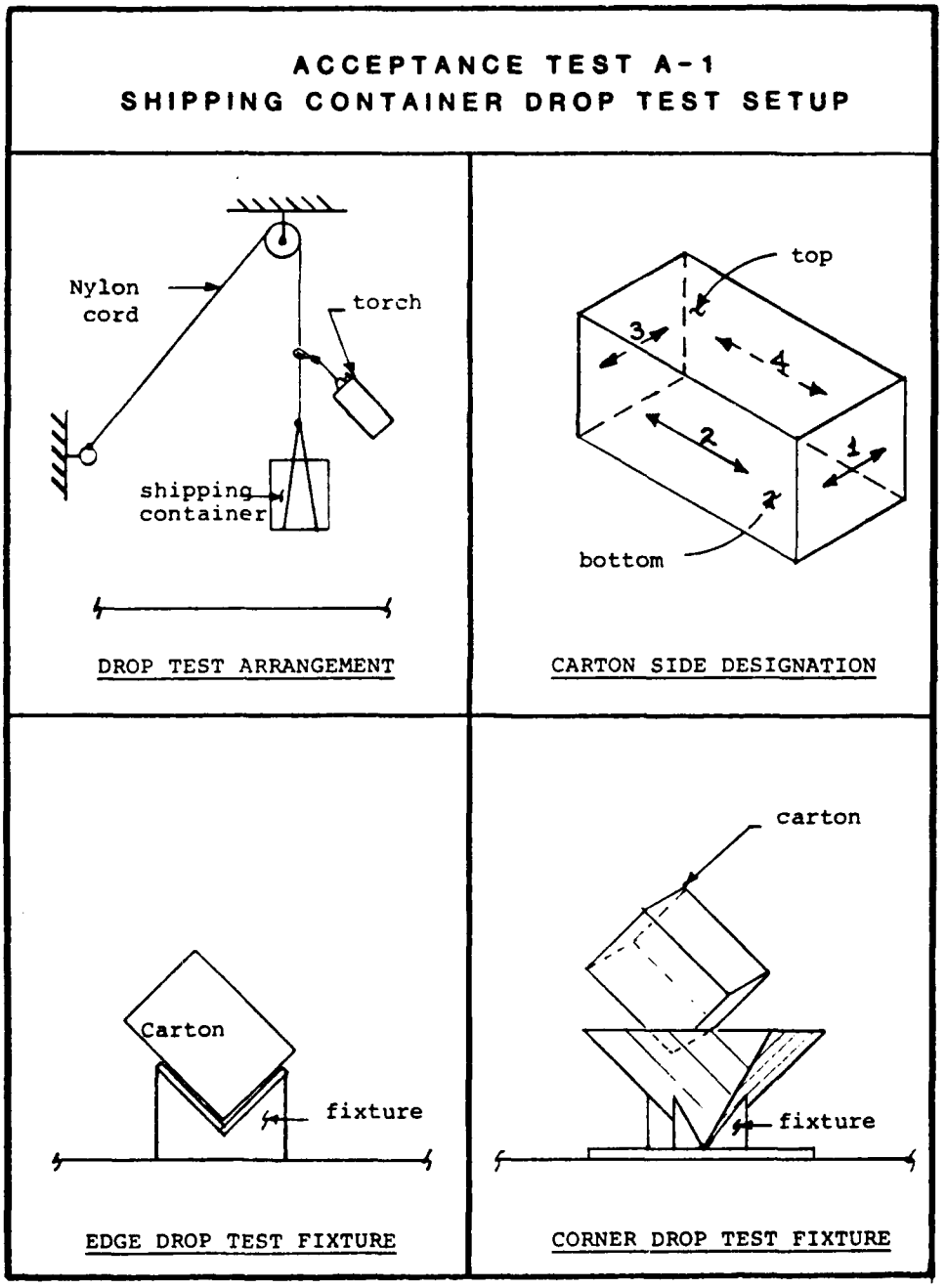


Figure 9. Acceptance test A-1, shipping container drop test setup

TABLE 7

ACCEPTANCE TEST A-2

UNIT LOAD DROP TEST PROCEDURE

Test samples shall be two unit loads. The first unit load shall consist of 48 baseline shipping containers containing all the varieties of Tray Packs and food listed in Table 6. The second unit load shall consist of 27 bundle-concept shipping containers also containing the varieties of Tray Packs listed in Table 6.

TEST PROCEDURE

(1) The unit load shall be lifted to a 6" height by a chain pull. After lifting, a 6" shim shall be placed under that side of the unit load.

(2) The opposite side of the unit load shall then be lifted to 6" height.

(3) The torch shall be used to melt the lifting cord releasing the unit load.

(4) Any damage shall be recorded on the data sheet.

(5) This procedure shall be repeated until all sides of the unit load have been dropped.

(6) The unit load shall then be unpacked shipping container by shipping container and the contents inspected for damage.

(7) Any damage shall be marked and recorded on the data sheet.

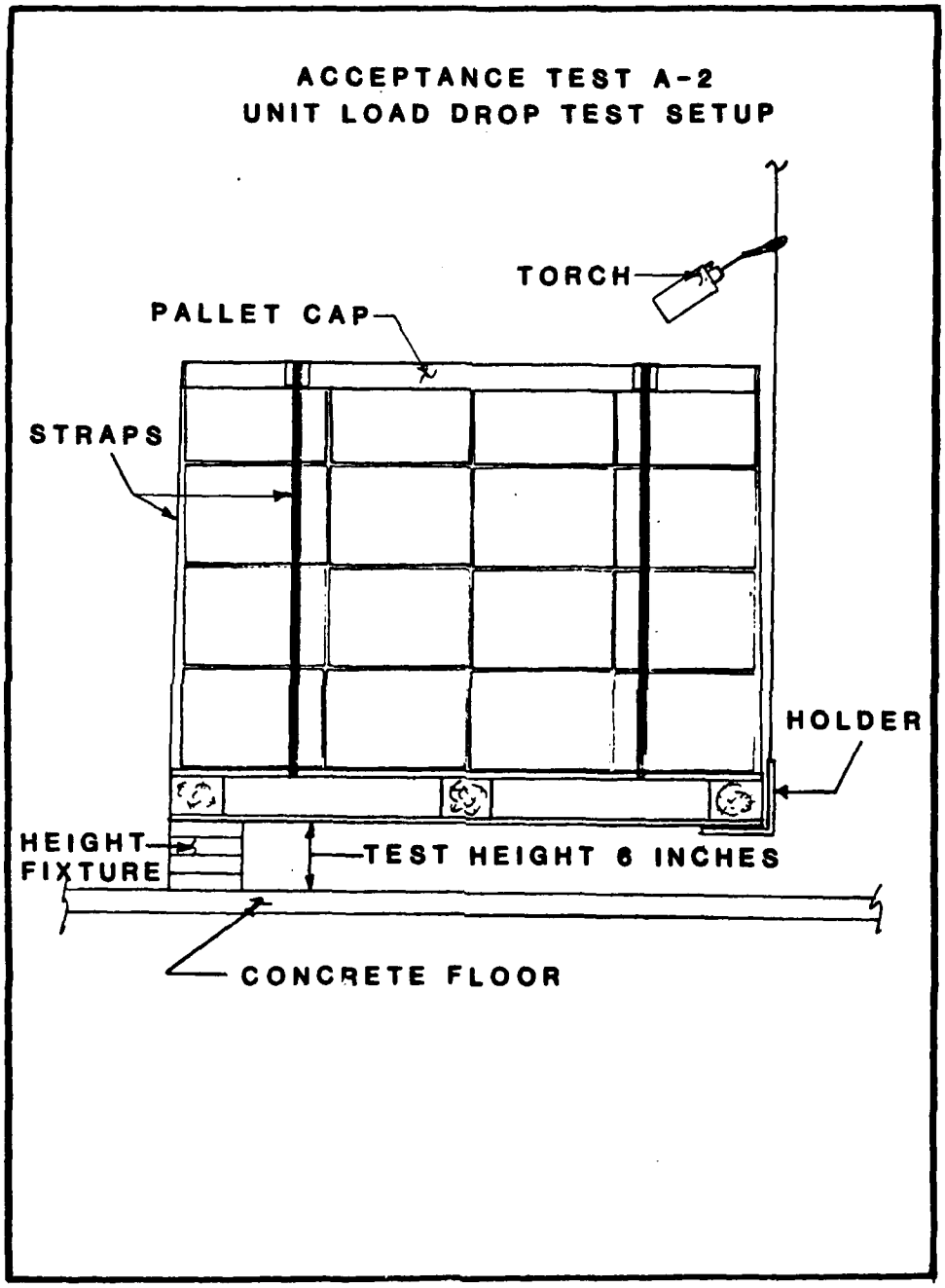


Figure 10. Acceptance test A-2, unit load drop test setup

TABLE 8

ACCEPTANCE TEST A-3

UNIT LOAD COMPRESSION TEST PROCEDURE

This test shall be performed on the unit loads tested in Acceptance Test A-2.

PROCEDURE

(1) The load fixture shall be centered on the unit load.
(2) Concrete block shall be added until the weight of one unit load is atop the test unit.
(3) The height of the unit load from the floor shall be measured and the results recorded on the data sheet.
(4) The load shall be left for 24 hours.
(5) The load shall be inspected for damage, and if it has not failed, the height shall be remeasured. The results shall be recorded on the data sheet.
(6) If the unit has failed, discontinue the test.
(7) If the unit has not failed, add concrete block to the weight of a second unit load and repeat procedure.
(8) Discontinue test after a test level of three unit loads weight have been placed atop the test unit.

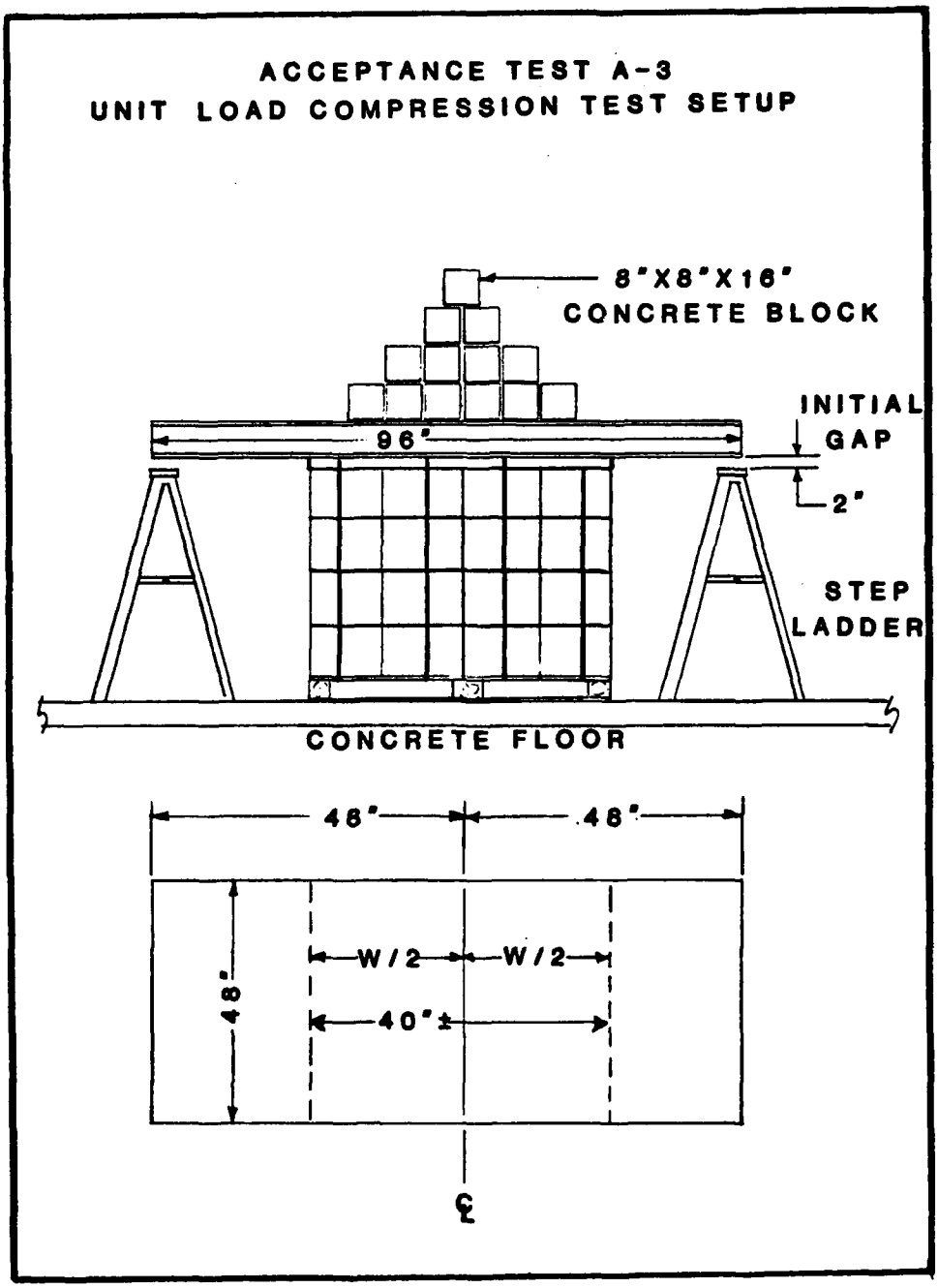


Figure 11. Acceptance test A-3, unit load compression test setup

TABLE 9

ACCEPTANCE TEST A-4

SHIPPING CONTAINER IMPACT TEST PROCEDURE

The test shall be performed on all the shipping containers tested under Acceptance Test A-1.

PROCEDURE

(1) Strap test container to back load containers.
(2) Raise to 14.5-inch height and level.
(3) Melt support string allowing load to drop.
(4) Unpack and examine shipping container.
(5) Mark damage and record in data sheet.

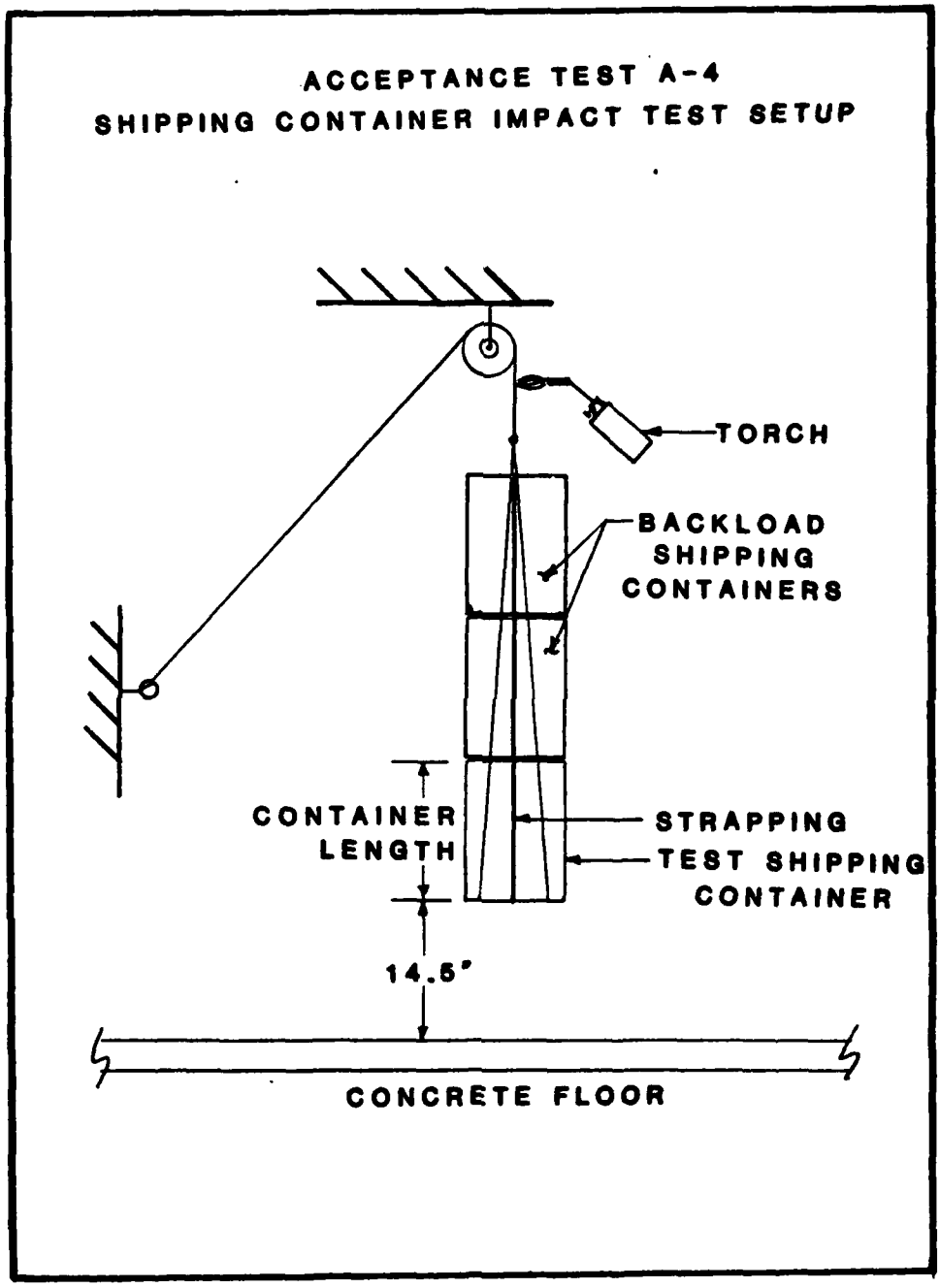


Figure 12. Acceptance test A-4, shipping container impact test setup

TABLE 10

ACCEPTANCE TEST A-6

SHIPPING CONTAINER VEHICLE LOOSE LOAD VIBRATION TEST PROCEDURE

This test shall be performed on the shipping containers tested in Test A-1.

PROCEDURE

(1) Mount shipping containers on shaker table. Do not strap down. (Mount in clusters of 9 to 12.) (Pallet shall be clamped to shaker with containers loose on top.)

(2) Adjust shaker for 0.5 g.

(3) Make a resonant search from 3 to 100 Hz recording all resonances.

(4) Dwell 10 minutes at each of four most severe resonances.

(5) If no resonance occurs, sweep for 40 minutes.

(6) Rotate shipping containers 90^{o} and repeat.

(7) Rotate shipping containers 90^{o} and repeat.

(8) Unpack shipping containers, mark damage, and record in log.

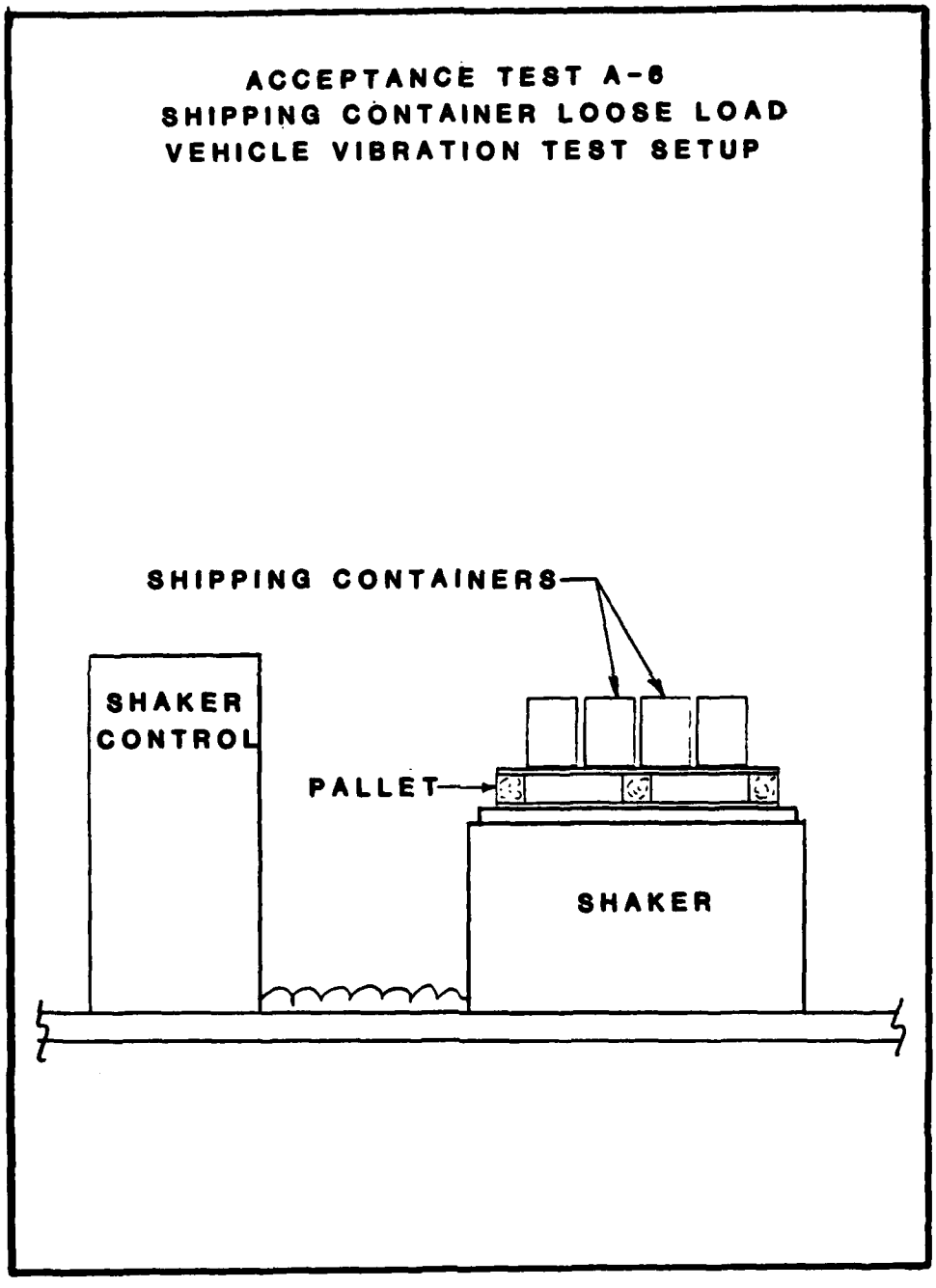


Figure 13. Acceptance test A-6, shipping container loose load vehicle vibration test setup

4. IMPROVED DURABILITY DESIGN CONCEPTS

Design requirements

The design concepts to be discussed below include changes to the Tray Pack and to the shipping container. The changes to the Tray Pack are those that improve the durability of the Tray Pack. The changes to the shipping container are those that improve its ability to absorb shock.

Each of these concepts has an impact on some aspect of utilizing Tray Packs and in particular on:

(1) The delivered cost of a filled Tray Pack.

This cost includes especially the cost of the Tray Pack and the cost of the shipping container in addition to the cost of the food.

The cost increase of an improved durability Tray Pack includes the cost of any additional material and the amortized cost of any additional equipment (such as a new Tray Pack mold).

The cost increase of an improved shock absorbing shipping container includes the increased cost of the new shipping container divided by the number of Tray Packs in the shipping container.

(2) The volume per unit weight of the new concept vs the old.

Any volume per unit weight increases from new concepts will result from increases in the volume of new shock absorbing shipping container concepts. To the extent that the volume of the shipping container is increased, that increase will result in a decrease in the number of Tray Packs per unit load.

If the number of unit loads per truck load and per rail freight car are fixed, then the result will be fewer Tray Packs per delivery making the new concept less desirable than the baseline concept.

However, should the truck load or freight car load be currently weight limited, or should it be possible to ship more unit loads of a new concept by stacking, then the increased volume of the new concept would have no impact.

Specifically, let us consider the case of the current or "baseline" shipping container packed 48 to the unit load vs the "bundle" concept, which will be described later, packed 27 to the unit load. As shown in Table 11, the bundle concept is comparable to the baseline concept with respect to units shippable per container load only for the case whereby the bundle concept containers can be shipped stacked two unit loads high, but the baseline concept is restricted to shipment one unit load high.

(3) The ability of the Tray Pack to be transported without damage.

Based on the studies of this program, the current Tray Pack and shipping container combination simply cannot withstand the loads imposed by the ASTM rough handling environment. Moreover, the Tray Pack appears to be unable to withstand inplant handling without damage.

Consequently, the central requirement is to make the Tray Pack more durable and to achieve that durability at minimum cost and at the minimum impact on the ability to ship it in volume.

The types of damage sustained by the Tray Pack have been discussed in previous sections and need not be repeated here. Our task has been to develop design concepts minimizing those types of damage.

TABLE 11

TRAY PACKS SHIPPABLE PER LOAD BY TRUCK AND RAIL

METHOD OF TRANSPORT	CARGO BAY DIMENSIONS	WEIGHT LIMIT	BASELINE CONCEPT SHIPPING CONTAINER			BUNDLE CONCEPT SHIPPING CONTAINER		
			1 U.L. HIGH	2 U.L. HIGH	LIMIT	1 U.L. HIGH	2 U.L. HIGH	LIMIT
TRUCK	44'x8'x8'	40,000 LBM	3840 T.P. 4 PER S.C. 48 S.C. PER U.L. 20 U.L. PER TRUCK 1500 LBM PER U.L. 30,000 LBM PER TRUCK	5120 T.P. 4 PER S.C. 48 S.C. PER U.L. 26 U.L. PER TRUCK 1500 LBM PER U.L. 40,000 LBM PER TRUCK	1 HIGH VOLUME LIMITED ——— 2 HIGH WEIGHT LIMITED	2160 T.P. 4 PER S.C. 27 S.C. PER U.L. 20 U.L. PER TRUCK 900 LBM PER U.L. 18,000 LBM PER TRUCK	4320 T.P. 4 PER S.C. 27 S.C. PER U.L. 40 U.L. PER TRUCK 900 LBM PER U.L. 36,000 LBM PER TRUCK	1 HIGH 2 HIGH BOTH VOLUME LIMITED
RAIL	64'x10'x12'	90,000 LBM	6912 T.P. 4 PER S.C. 48 S.C. PER U.L. 36 U.L. PER CAR 1500 LBM PER U.L. 54,000 LBM PER CAR	11,520 T.P. 4 PER S.C. 48 S.C. PER U.L. 60 U.L. PER CAR 1500 LBM PER U.L. 90,000 LBM PER CAR	1 HIGH VOLUME LIMITED ——— 2 HIGH WEIGHT LIMITED	3888 T.P. 4 PER S.C. 27 S.C. PER U.L. 36 U.L. PER CAR 900 LBM PER U.L. 32,400 LBM PER CAR	7776 T.P. 4 PER S.C. 27 S.C. PER U.L. 72 U.L. PER CAR 64,800 LBM PER CAR	1 HIGH 2 HIGH BOTH VOLUME LIMITED

T.P. = TRAY PACK

S.C. = SHIPPING CONTAINER

U.L. = UNIT LOAD

The heavy weight Tray Pack concept

The current or baseline Tray Pack is manufactured with an 85-pound lid and a 75-pound can or bottom. The heavyweight Tray Pack tested under this program was manufactured with a 90-pound lid and a 90-pound bottom. Table 12 presents the thickness and stiffness ratio (ration of cube of thickness) of each weight material.

As can be seen from the table, the 90# material is 0.0016 inches thicker and 70% stiffer than the 75# material. In addition, the material has much greater resistance to denting by local percussion loads -- in other words, a much more rugged and durable container.

Manufacture of the increased weight Tray Pack is accomplished using the same tooling currently used by Central States. The cost increase of the Tray Pack is confined to the extra cost of the steel in the Tray Pack. Table 13 is a comparision of costs for heavyweight Tray Pack containers vs current weight Tray Pack containers. As can be seen from the Table the cost increase on a filled container is only 1.2%.

TABLE 12

TRAY PACK MATERIAL WEIGHT, THICKNESS, AND STIFFNESS

WEIGHT	THICKNESS	STIFFNESS RATIO
75#	0.0083"	1,000
80#	0.0088"	1,192
85#	0.0094"	1,453
90#	0.0099"	1,697
95#	0.0105"	2,025
100#	0.0110"	2,328

TABLE 13

ESTIMATED

TRAY PACK COST BREAKDOWN FOR

A CARTON OF FOUR

ITEM AND NUMBER	PRESENT COST 85# LID 75# BOTTOM	NEW COST 90# LID 90# BOTTOM	PERCENT INCREASE
TRAY PACK BOTTOM - 4	$ 1.51	$ 1.78	18%
TRAY PACK TOP - 4	0.99	1.08	9
SHIPPING CONTAINER CARTON - 1	0.85	0.85	0
SHIPPING CONTAINER LINEAR - 1	0.45	0.45	0
SHIPPING CONTAINER PADS - 5	0.50	0.50	0
TRAY PACK CONTENTS (LASAGNA)	25.70	25.70	0
TOTAL	$ 30.00	$ 30.36	1.2%
PER TRAY PACK	$ 7.50	$ 7.59	1.2%
CONTENTS	$ 6.42	$ 6.42	0
TRAY PACKS	0.625	0.715	14%
SHIPPING CONTAINER	$ 0.45	0.45	0

The reinforced Tray Pack

The concept of the reinforced Tray Pack was developed and tested here over the period of months. Our earliest experiments revealed paneling due to side dropping as the cause of the type of damage which was of most concern to U.S. Army Natick Labs.

We reproduced this damage by imposing a vacuum on the container.

We glued reinforcing strips onto the corners and determined that an increased vacuum and higher drop height was required to induce failure. We increased the number of the strips and placed them for maximum effectiveness. The result was a Tray Pack extremely resistant to damage by side dropping.

This concept is shown in Figure 14.

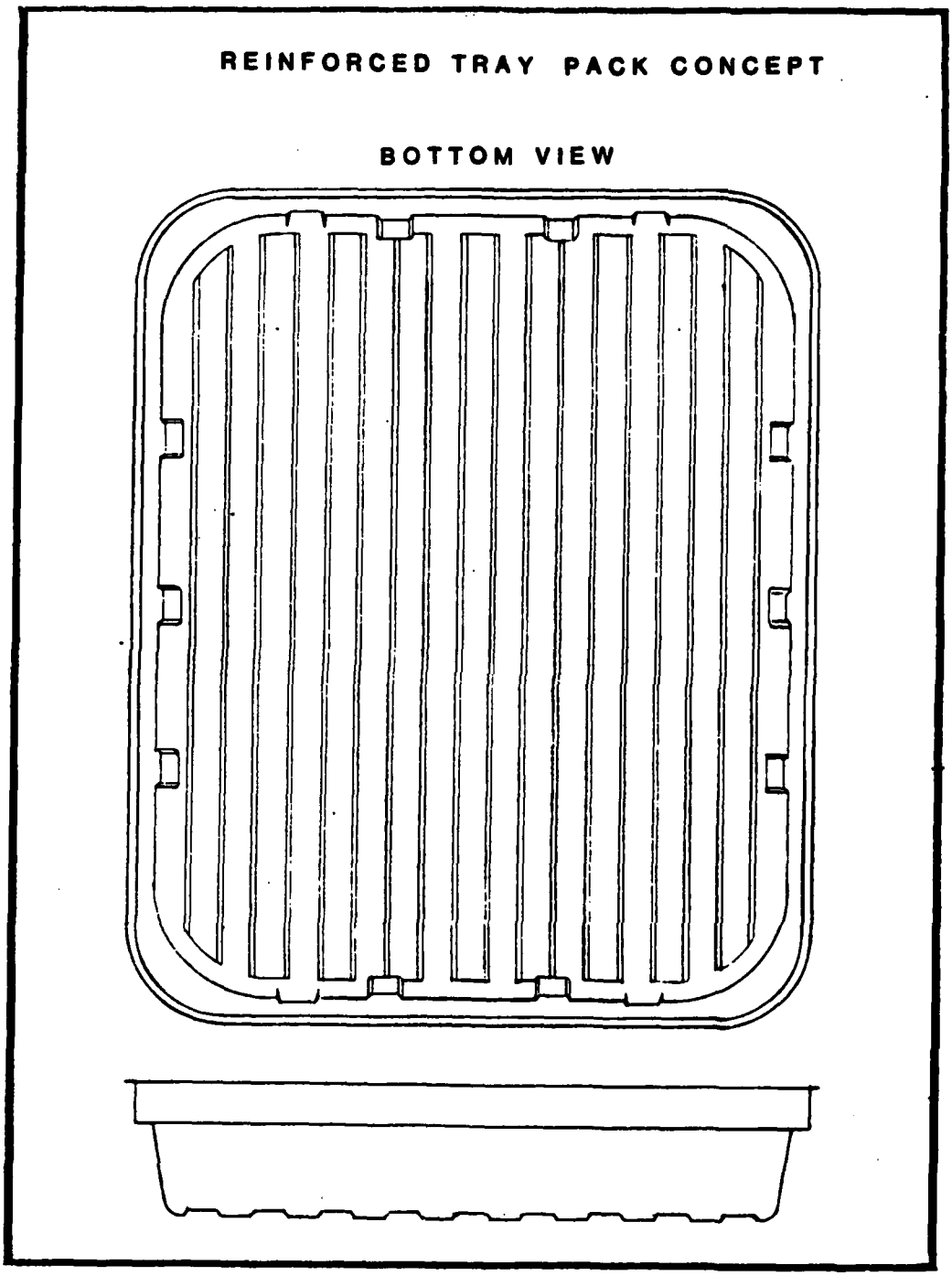


Figure 14a. Reinforced Tray Pack concept

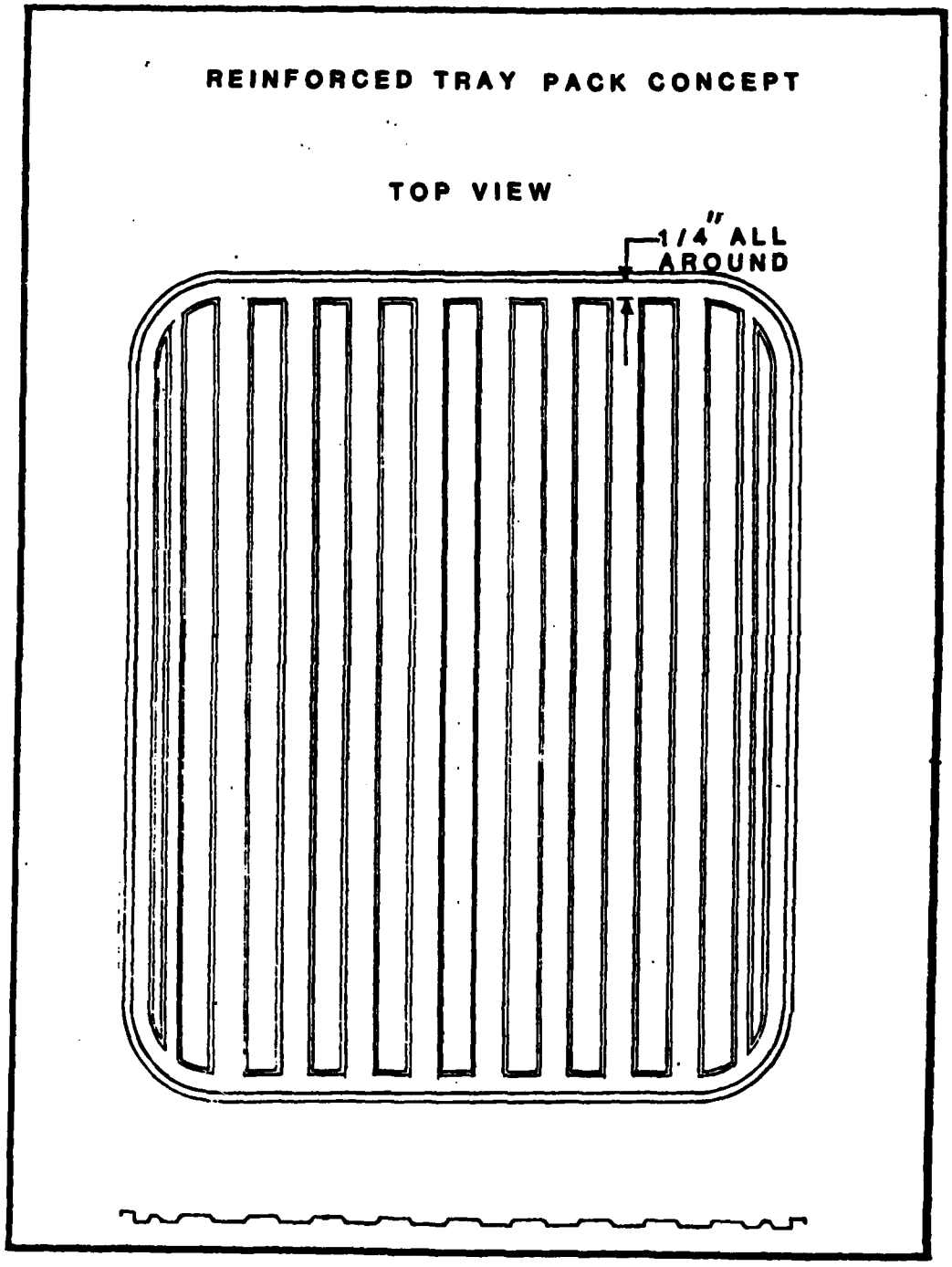


Figure 14b. Reinforced Tray Pack concept

Bundle concept shipping container

The idea of using the shipping container to absorb the shocks of the Tray Pack rough handling invironment is entirely suited to solving the problems posed by the ASTM "Proposed Recommended Practice for Performance Testing of Shipping Containers".

This specification covers every transportation environment and for each environment the Tray Pack is packaged in a shipping container so that the shipping container can be used to absorb the shocks of that environment.

However, a shock absorbing shipping container cannot protect the Tray Pack from rough handling in the packer's plant or at the point of use.

We developed and tested two shipping container shock absorbing concepts; the foam pad concept and the bundle concept. The foam pad concept did not live up to its promise under test and was discarded after evaluation testing.

The bundle concept, shown in Figure 15, performed quite well under evaluation testing and was therefore included in our Acceptance Testing Program. As can be seen from Figure 15, this concept requires more parts and a larger box than the baseline shipping container concept. Consequently, its cost is greater as shown in Table 14. The cost is increased per filled Tray Pack by 8.3%

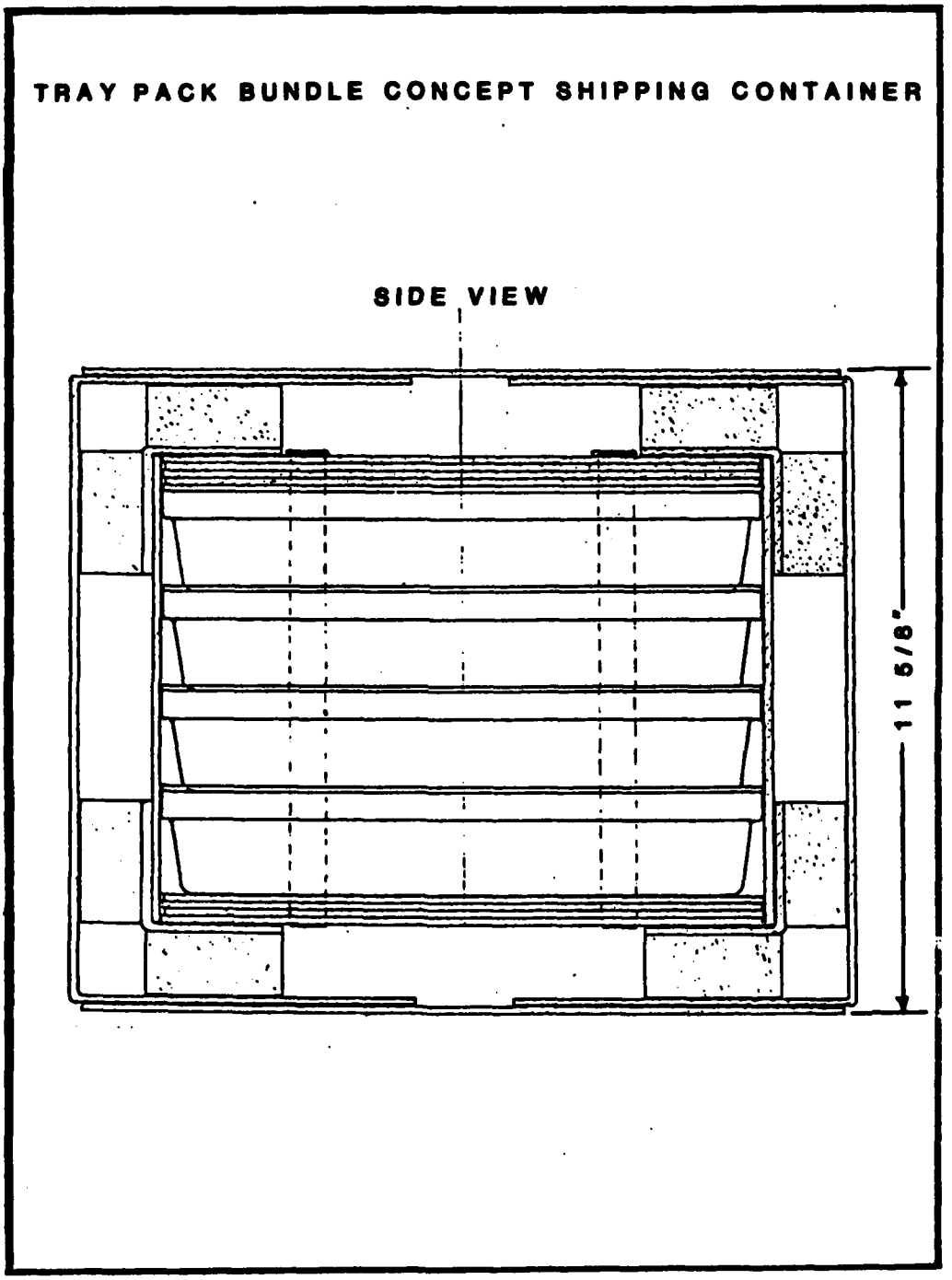


Figure 15a. Tray Pack bundle concept shipping container

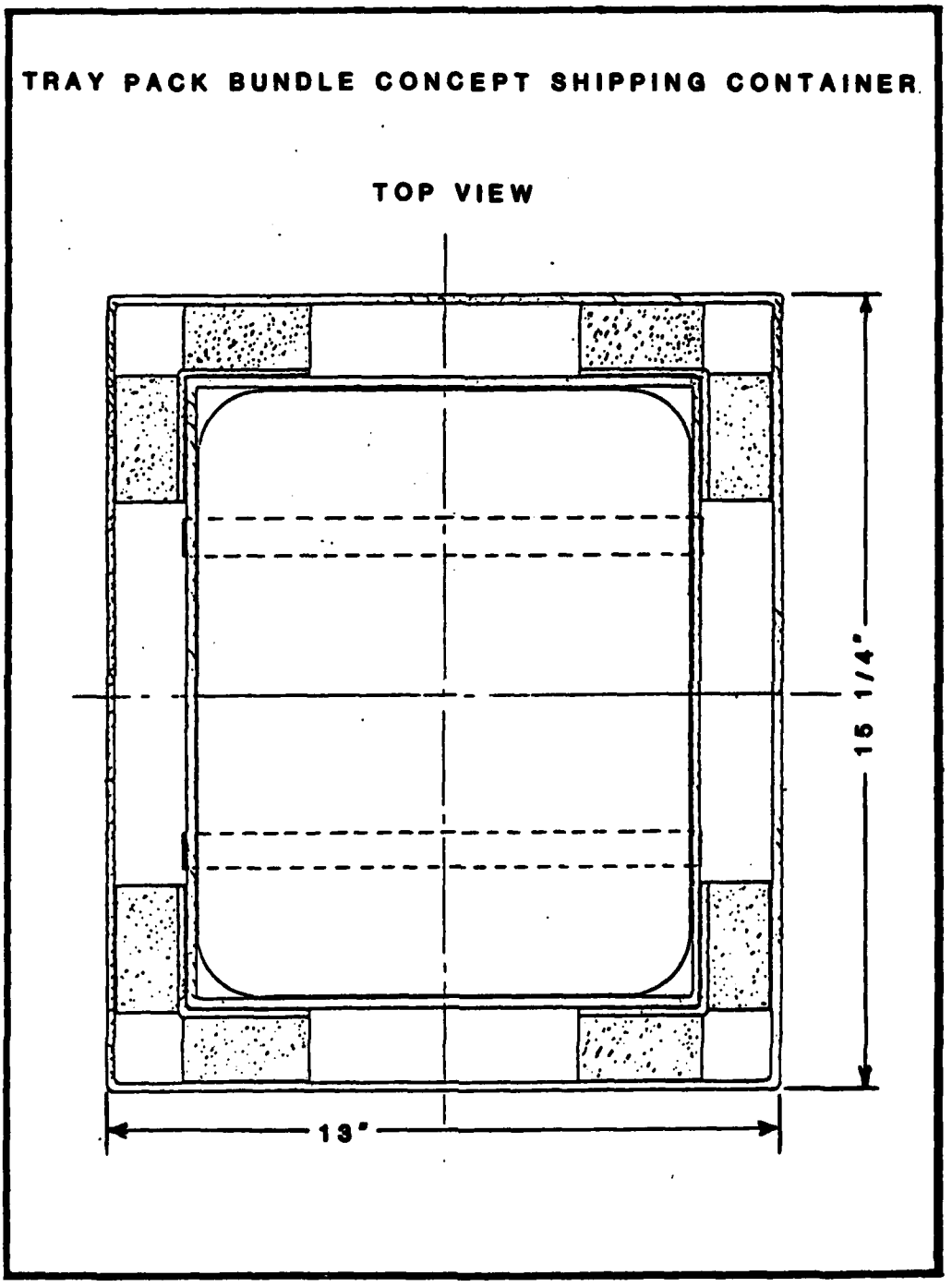


Figure 15b. Tray Pack bundle concept shipping container

TABLE 14

TRAY PACK SHIPPING CONTAINER COST COMPARISON

	CURRENT CONCEPT		BUNDLE CONCEPT	
ITEM	NUMBER	COST	NUMBER	COST
SHIPPING CONTAINER CARTON	1	$0.85	1	$0.90
SHIPPING CONTAINER LINER	1	$0.45	1	$0.50
SHIPPING CONTAINER PADS - CARDBOARD	5	$0.50	8	$0.80
FOAM PADS	0	---	8	$2.00
STRAPPING	0	---	2	$0.10
TOTAL		$1.80		$4.30
TRAY PACK COST (INCLUDING PACKAGING)		$7.50		$8.13

5. RESULTS OF INCOMING INSPECTION

Incoming inspection was conducted in four stages:

(1) Inspection of incoming lasagna in baseline Tray Pack containers.

(2) Inspection of incoming peas in baseline Tray Pack containers.

(3) Inspection of incoming peas in 90-pound Tray Pack containers.

(4) Inspection of incoming lasagna in 90-pound Tray Pack containers.

The inspection reports are presented in Appendix A.

Almost all of the damage to the Tray Packs was found on the Tray Pack bottoms or cans with only occasional damage found to the top or lid. Almost all of the damage to the Tray Pack bottoms was to the corner or edges with only occasional dents to the central portion.

Except in a few isolated cases the shipping containers were in excellent condition leading us to strongly believe that the denting type damage we found was due to handling in the packer's plant rather than to anything occurring during shipment.

The Tray Packs received were shipped by truck, either common carrier or by company truck. The Tray Packs were shipped, 4 to a carton. The cartons were baseline shipping containers of V3c material. The shipping containers were delivered on pallets. The pallets were not stacked. We unloaded the shipping containers carefully, one at a time, from the truck.

In unpacking the shipping containers, we noted that the shipping containers from Blue Star (Peas) were larger than those from Vanee (Lasagna), so that they were able to move around more freely in the container. Also, the Tray Packs are more free to bulge and buckle, and hence are somewhat more subject to damage. We suggest that the packing specs be written to require a more snug fit.

A detailed description of carton sizes is presented in Appendix B.

The damage to the Tray Packs was of two types; (1) paneling, (2) denting. Examples of this damage are shown in Figures 16 and 17.

Table 15 shows that of the baseline containers received 37% of the Lasagna and 20% of the peas were received with pronounced damage. By switching to the 90-pound material, this damage was reduced to 9% for the Lasagna and 13% for the peas.

Table 16 shows that 28% of the damage to the baseline Lasagna was due to pronounced dents, while only 14% was due to pronounced panels, whereas the baseline peas had roughly the same amount of pronounced dents as pronounced panels.

TABLE 15

DISTRIBUTION OF DAMAGE TO TRAY PACKS FOUND DURING INCOMING INSPECTION

TRAY PACK TYPE	NUMBER RECEIVED	UNDAMAGED	MINOR DAMAGE	MAJOR DAMAGE
BASELINE LASAGNA	108	37%	26%	37%
90-POUND LASAGNA	32	72%	19%	9%
BASELINE PEAS	108	42%	38%	20%
90-POUND PEAS	39	36%	51%	13%

TABLE 16

DISTRIBUTION OF TRAY PACK DAMAGE TYPES FOUND DURING INCOMING INSPECTION

NOTE: SOME TRAY PACKS HAD MORE THAN ONE TYPE OF DAMAGE

TRAY PACK TYPE	NUMBER RECEIVED	MINOR PANEL	MAJOR PANEL	SLIGHT DENT	PRONOUNCED DENT
BASELINE LASAGNA	108	24%	14%	47%	28%
90-POUND LASAGNA	32	4%	0%	72%	9%
BASELINE PEAS	108	19%	10%	28%	12%
90-POUND PEAS	39	26%	3%	33%	13%

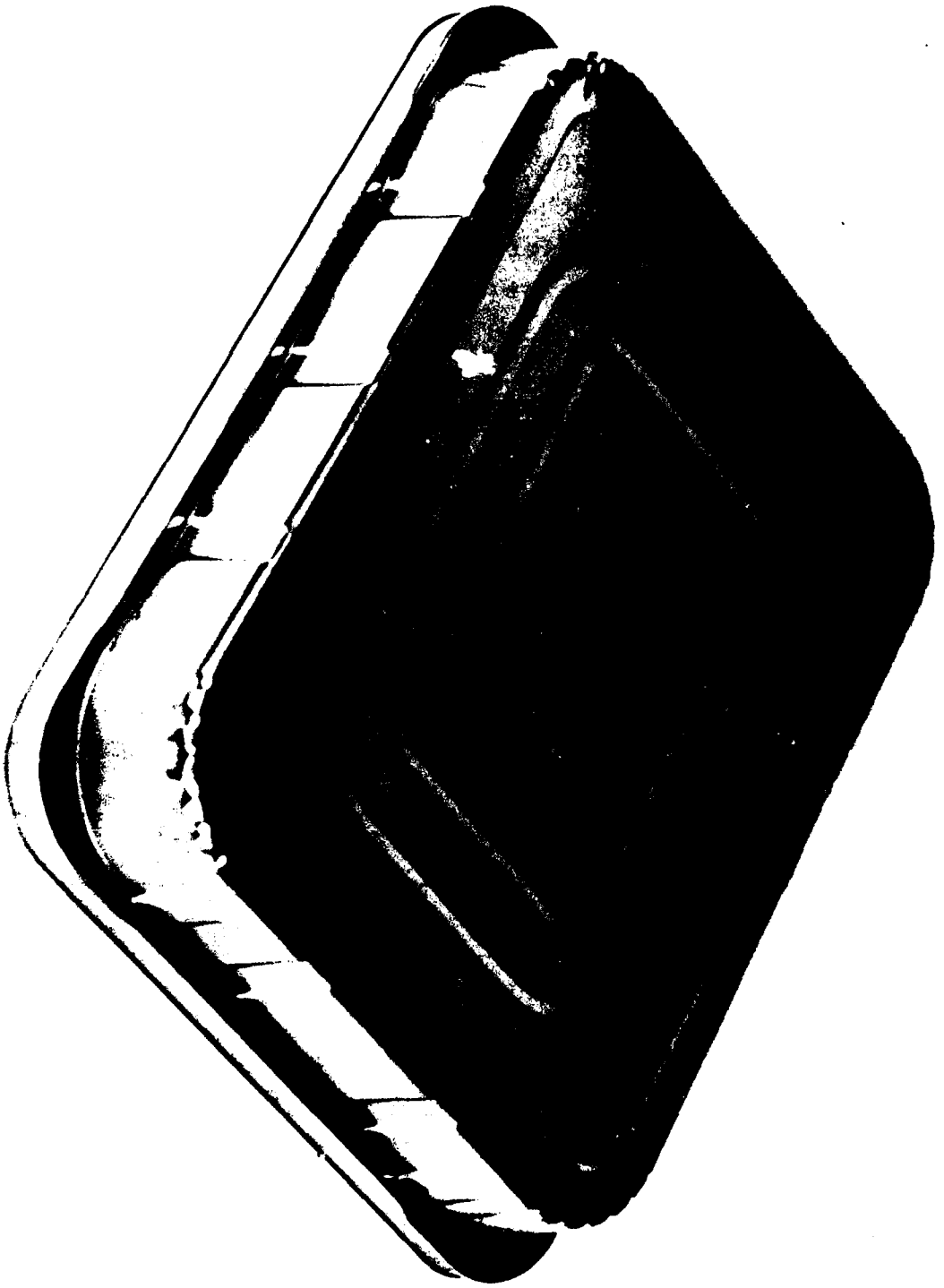


Figure 16. Tray Pack paneling damage

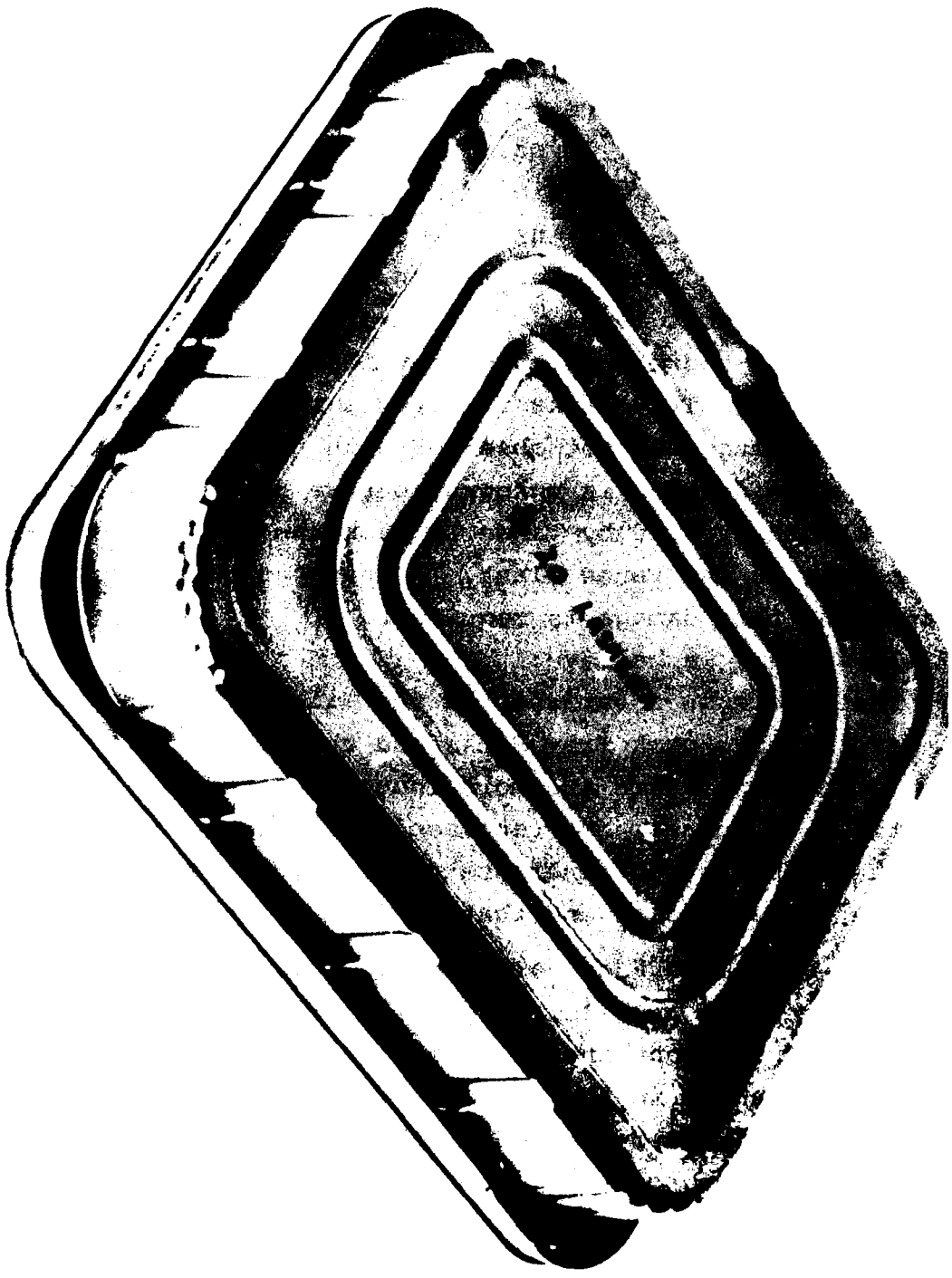


Figure 17. Tray Pack denting damage

It should be noted that some of the panels found in the peas were very very deep. We noted that the peas were filled to 6 lb. 8 oz. while the Lasagna was filled to 6 lb. 10 oz. The result of underfilling is that the vacuum level in the peas is much higher making it more susceptible to paneling damage. Consequently, we suggest that Army specifications require filling to 6 lb. 10 oz. to reduce the vacuum and hence the damage. We have questioned Blue Star about why they fill to 6 pounds 8 oz. rather than 6 pounds 10 oz. and they stated that there was no particular reason except that they had always filled to that level.

Moreover, there were many many pronounced grooves, gashes and dents in the Tray Packs of lasagna received. This same pattern of damage was not observed with the peas received. The cause of this denting is unknown, but we believe it must be due to the machinery used by Vanee to pack the lasagna or due to mishandling at the Vanee Plant. We suggest that further investigation of this damage is required.

In summary we believe:

(1) That there is a variance in the size of the shipping containers used to pack Tray Packs and that the Tray Packs in the larger containers are more loosely packed and more susceptible to damage. We recommend that the specifications for the shipping containers be changed so that all containers are the same size and that the Tray Packs fit snugly in them.

(2) That some Tray Packs are packed with only 6 lb. 8 oz. of food rather tan 6 lb. 10 oz. (105 fluid oz.) which is the size of the container. We believe that this results in a higher vacuum in the container making it more susceptible to damage. We recommend that all foods be packed to maximum fluid capacity from now on.

(3) That the 90-lb. Tray Pack is measurably more durable than the baseline. We recommend that the 90-pound Tray Pack be adopted as the standard weight for future Army shipments.

(4) That there are important sources of Tray Pack damage within the packer's plant. We recommend that this problem be the subject of further studies.

6. RESULTS OF EVALUATION TESTS

Four types of Evaluation Testing were conductd.

(1) Tray Pack Vacuum Tests
(2) Tray Pack Side Drop Tests
(3) Shipping Container Side Drop Tests
(4) Shipping Container Crush Tests

The data sheets for these tests are presented in Appendix C.

Tray Pack vacuum tests

The Tray Pack Vacuum Tests were conducted in order to observe paneling failure and to compare the level of vacuum required to induce that failure for improved durability concepts vs the baseline concept. The basis of the vacuum test is our belief that there is a relationship

$$h = K \frac{\Delta P}{\rho g}$$

between the height of Tray Pack drop (h) and the level of vacuum (ΔP) where ρ is the density of the Tray Pack contents, K is a constant and g is the acceleration of gravity. We believe that hydrodynamic forces created within the Tray Pack contents at the moment of impact induce vacuum forces on one part of the Tray Pack and overpressure forces on the opposite part. Because of this belief we feel that a vacuum test can be used to create the identical paneling failure as the drop test.

Table 17 is a summary of the prefailure vacuum levels achieved by each of the sample types tested. The sample concepts are depicted in Figures 18, 19, 20, 21. Each succeeding concept represents a greater degree of reinforcement. Each succeeding concept also is capable of withstanding a greater degree of vacuum. The last two concepts incurred panels which developed quite slowly, in a very controlled manner, as opposed to the instantaneous change incurred by the first two concepts indicating that the paneling is induced by means of a different mechanism.

Be that as it may, the behavior characteristics of the latter two concepts were such as to indicate a much stiffer container.

TABLE 17

TRAY PACK INTERIOR

VACUUM LEVELS ACHIEVED BEFORE FAILURE

TRAY PACK CONCEPT	VACUUM LEVEL	FAILURE TYPE
BASELINE	2.5" HG	DEEP INDENT PANELS DIAGONALLY OPPOSITE CORNERS
CROSS REINFORCED AT BOTTOM	2.5" HG	REINFORCEMENT SUPPORTS BROKE FREE
BOTTOM REINFORCED ACROSS WIDTH TO WITHIN 3/9" OF EDGE	3.31" HG	VERY CONTROLLED PANEL
TOP AND BOTTOM REINFORCED ACROSS WIDTH TO EDGE	4.12" HG	SINGLE SLIGHT CORNER PANEL VERY CONTROLLED

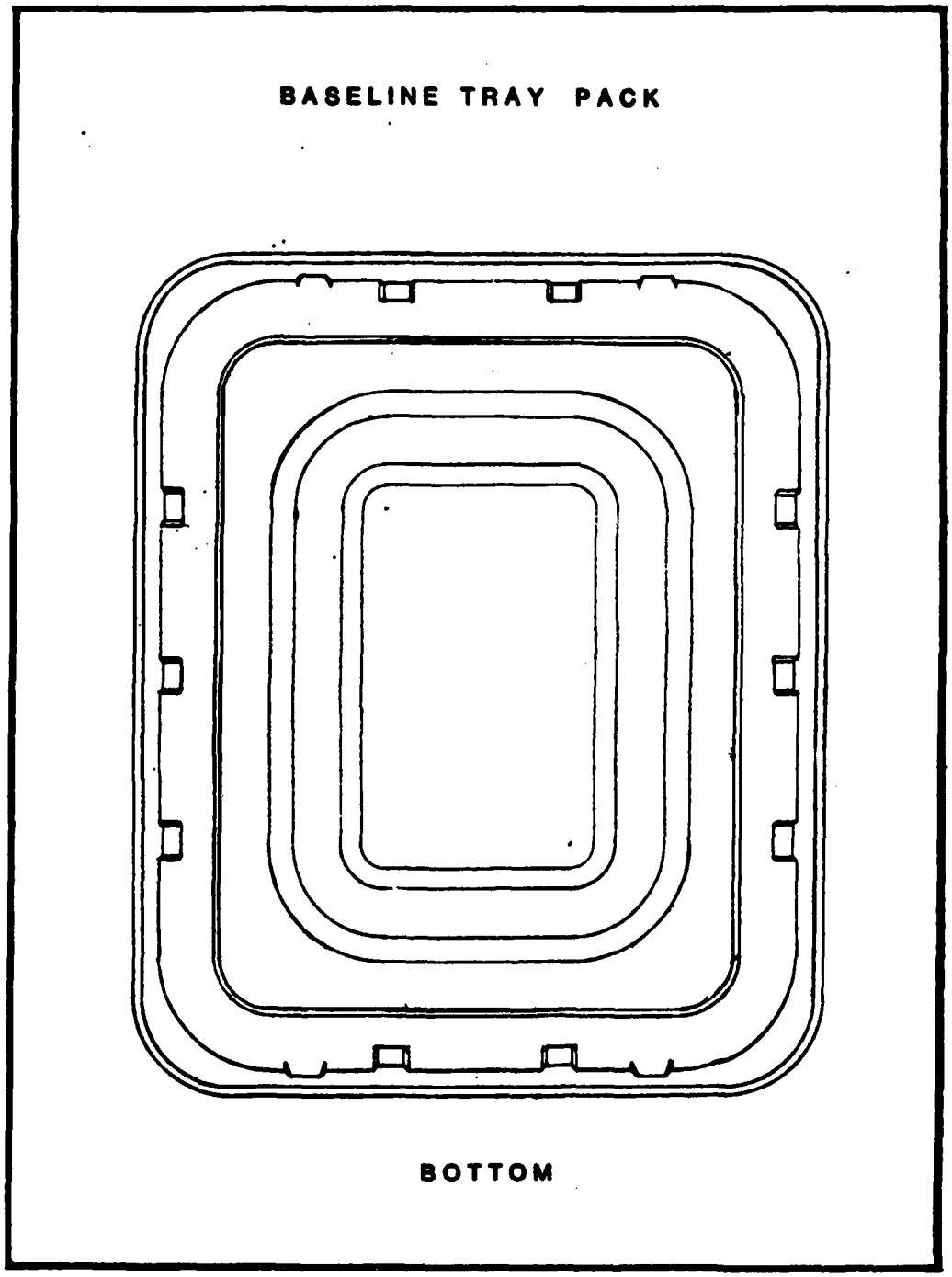


Figure 18a. Baseline Tray Pack

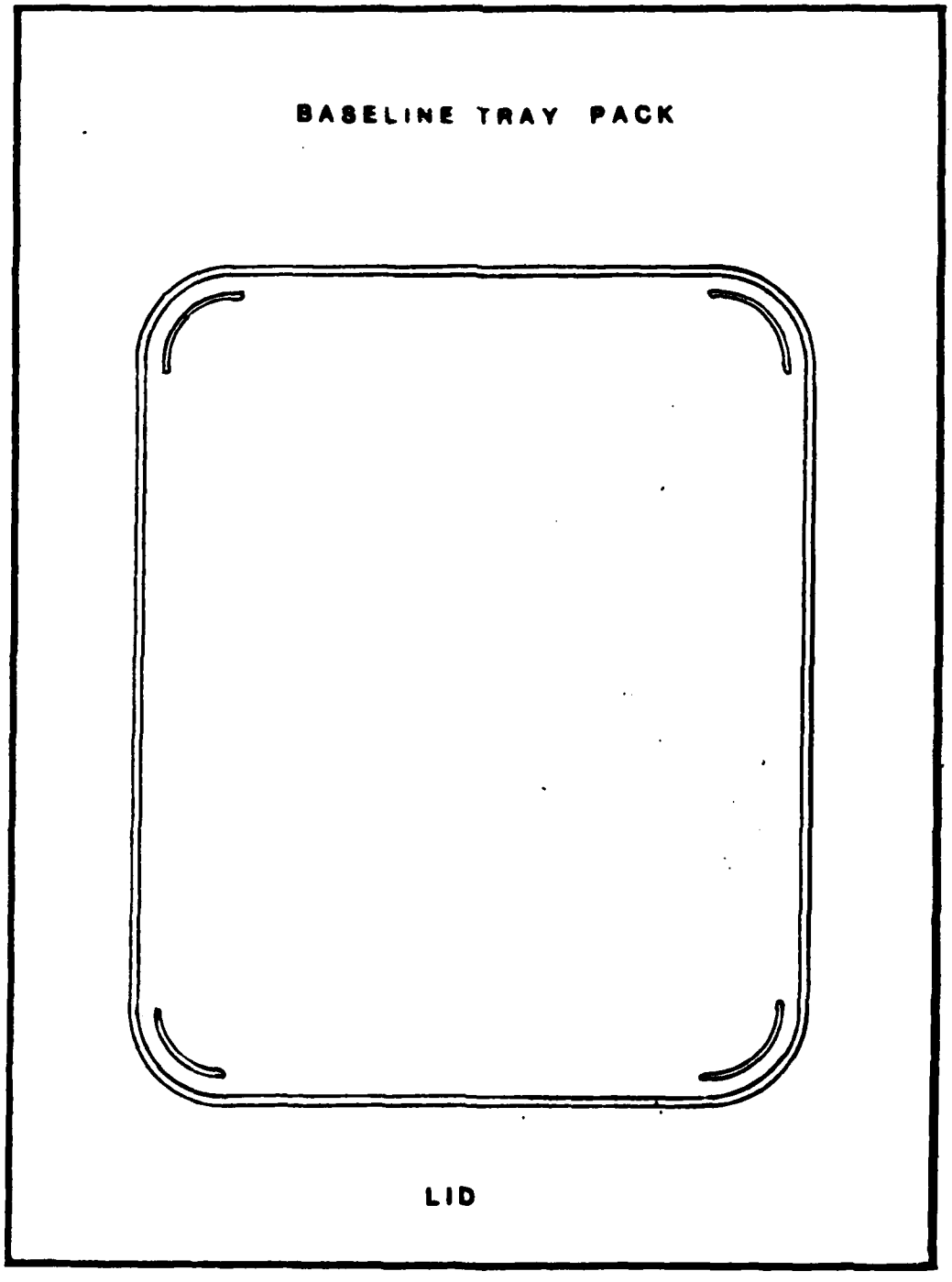


Figure 18b. Baseline Tray Pack

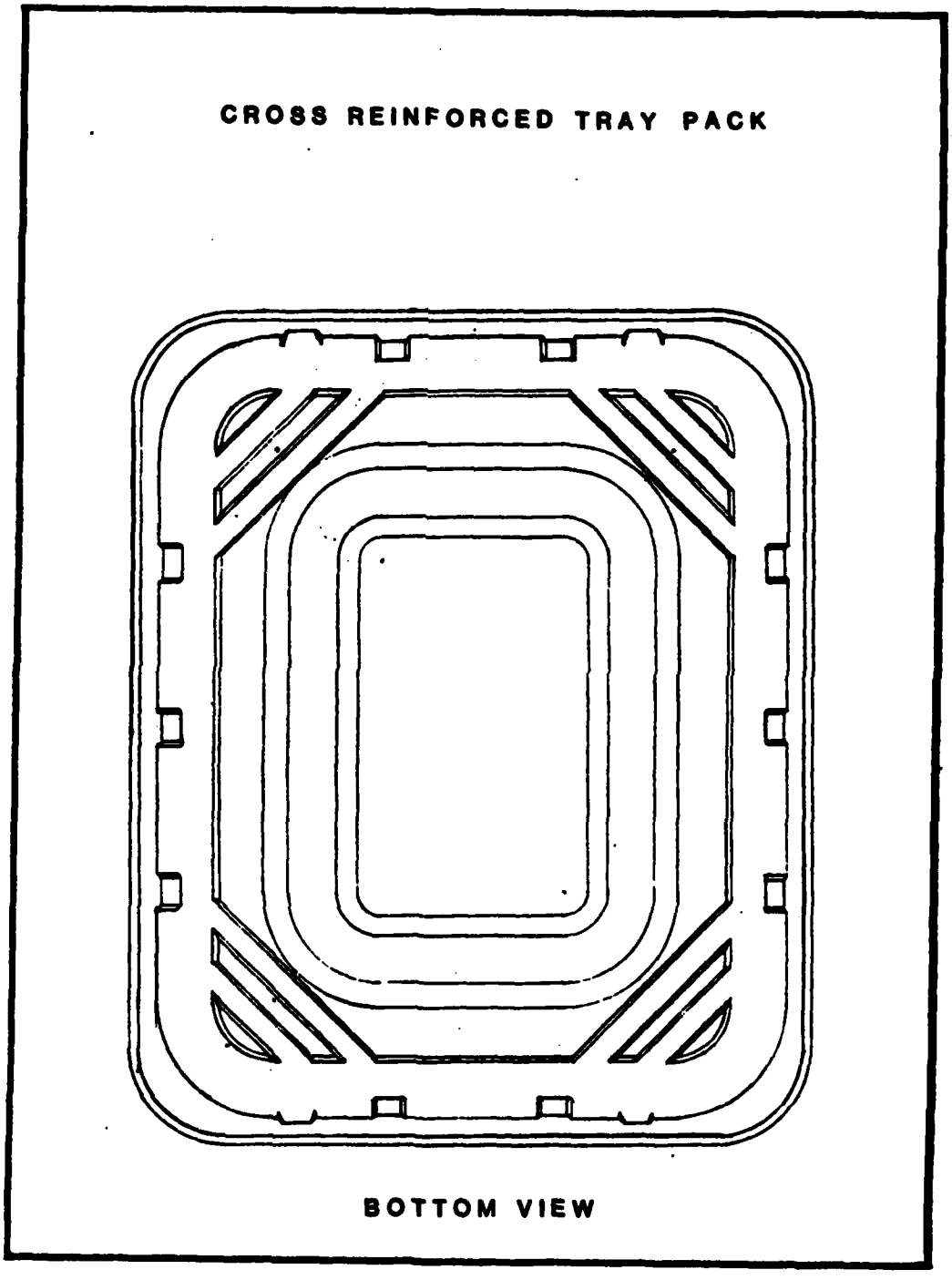


Figure 19. Cross reinforced Tray Pack

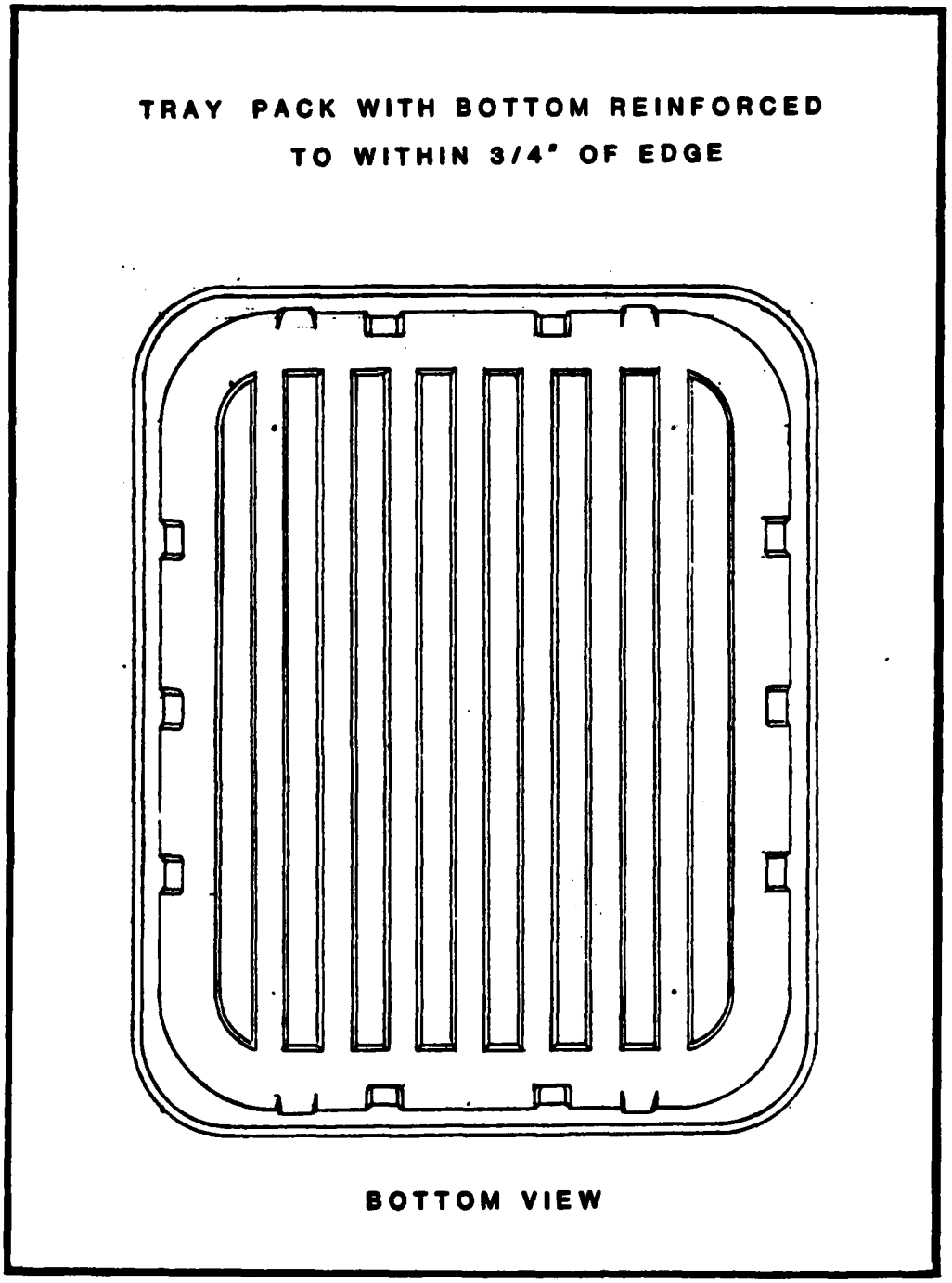


Figure 20. Tray Pack with bottom reinforced to within 3/4" of edge

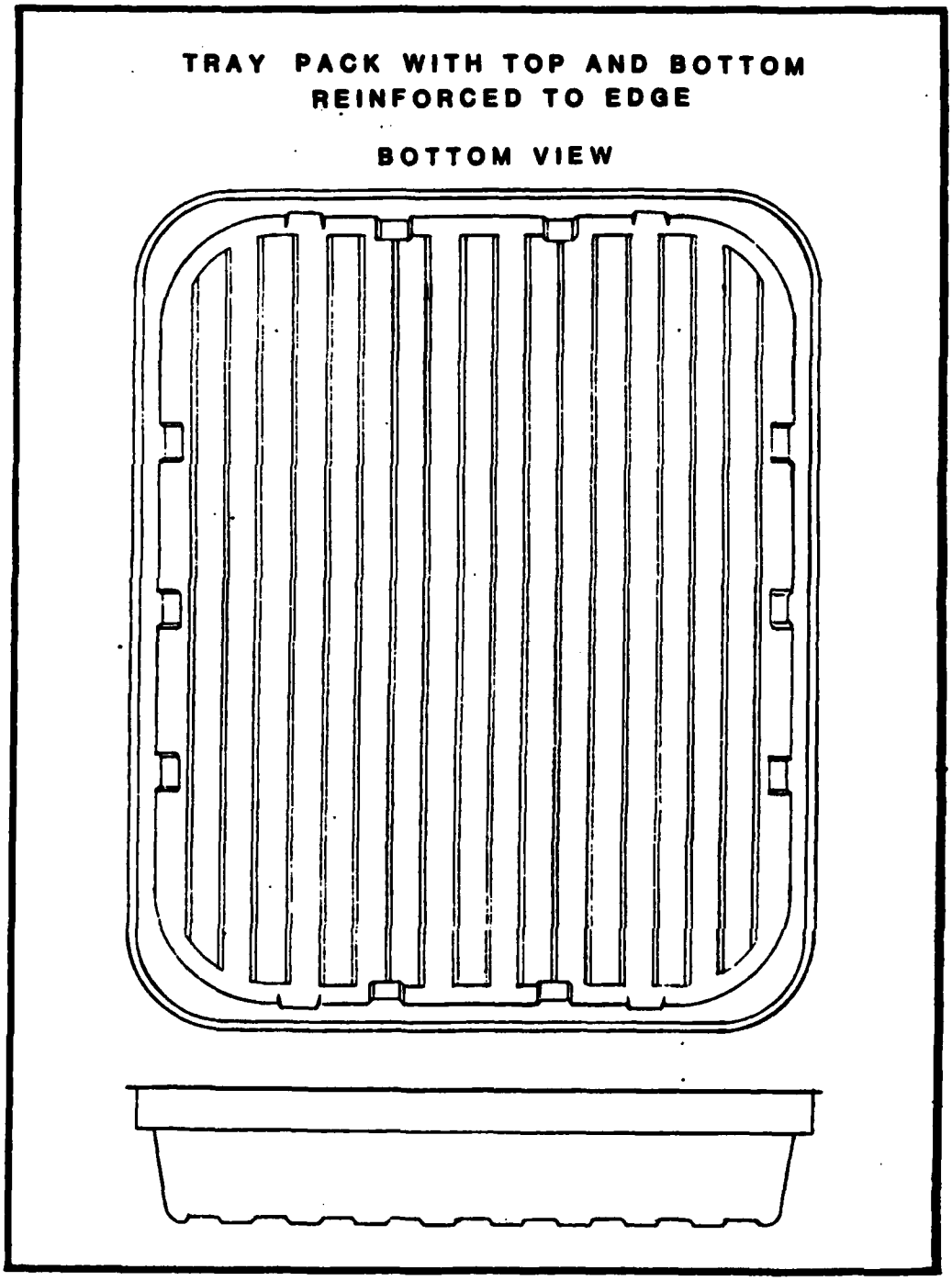


Figure 21a. Tray Pack with top and bottom reinforced to edge

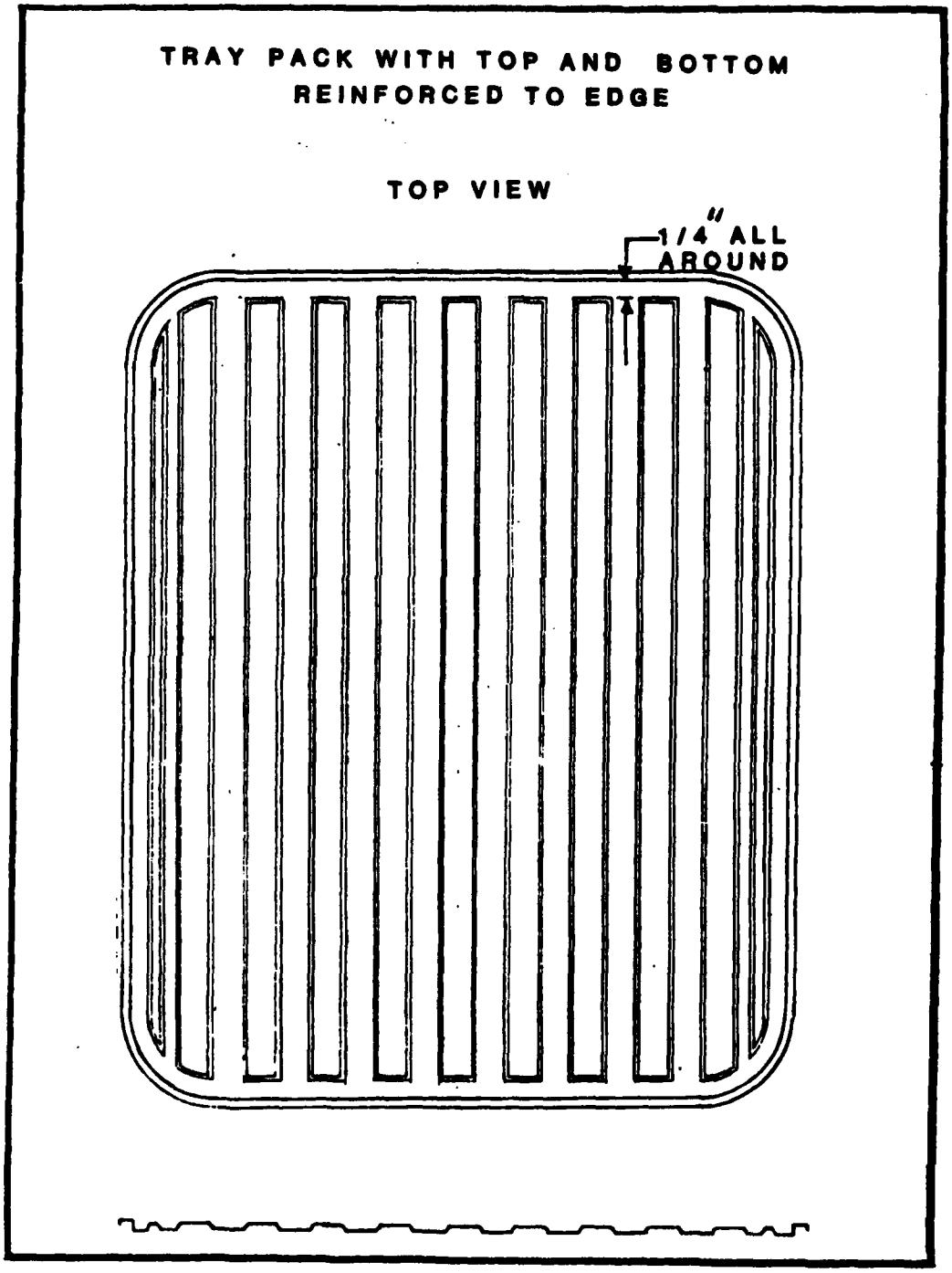


Figure 21b. Tray Pack with top and bottom reinforced to edge

Tray Pack side drop tests

At the beginning of the Tray Pack program we received several Tray Pack samples including one packed with scalloped potatoes. This particular sample was subject to a variety of informal drop tests to determine damage effect. The Tray Pack was dropped on top, bottom, and corner without spectacular results. However, when dropped on its side, the Tray Pack was distorted as shown in Figure 22. The paneling damage shown was exactly the damage that Natick personnel had indicated was the major cause of concern about Tray Pack durability. Consequently we developed the Side Drop Test as a measure of Tray Pack durability.

There are a number of factors impacting the results of a Side Drop Test. These are:

(1) The height of drop.
(2) The type of food packed.
(3) The amount of food packed.
(4) The level of vacuum in the container.
(5) The durability of the Tray Pack.

In order to conduct the test according to the scientific method, it is necessary that we vary only one variable at a time holding the others constant.

Height of drop tests

The first height of drop tests were run using a baseline Tray Pack. Failure occurred at a drop height of 6 . This test allows us to determine the constant relating the vacuum test to the Drop Test as:

$$h = 0.178\left(\frac{\Delta P}{\rho g}\right)$$

where

ΔP is in $\left(\frac{slug\ ft}{sec^2\ ft^2}\right)$

ρ is in $\left(slug/ft^3\right)$

g is in $\left(ft/sec^2\right)$

h is in ft

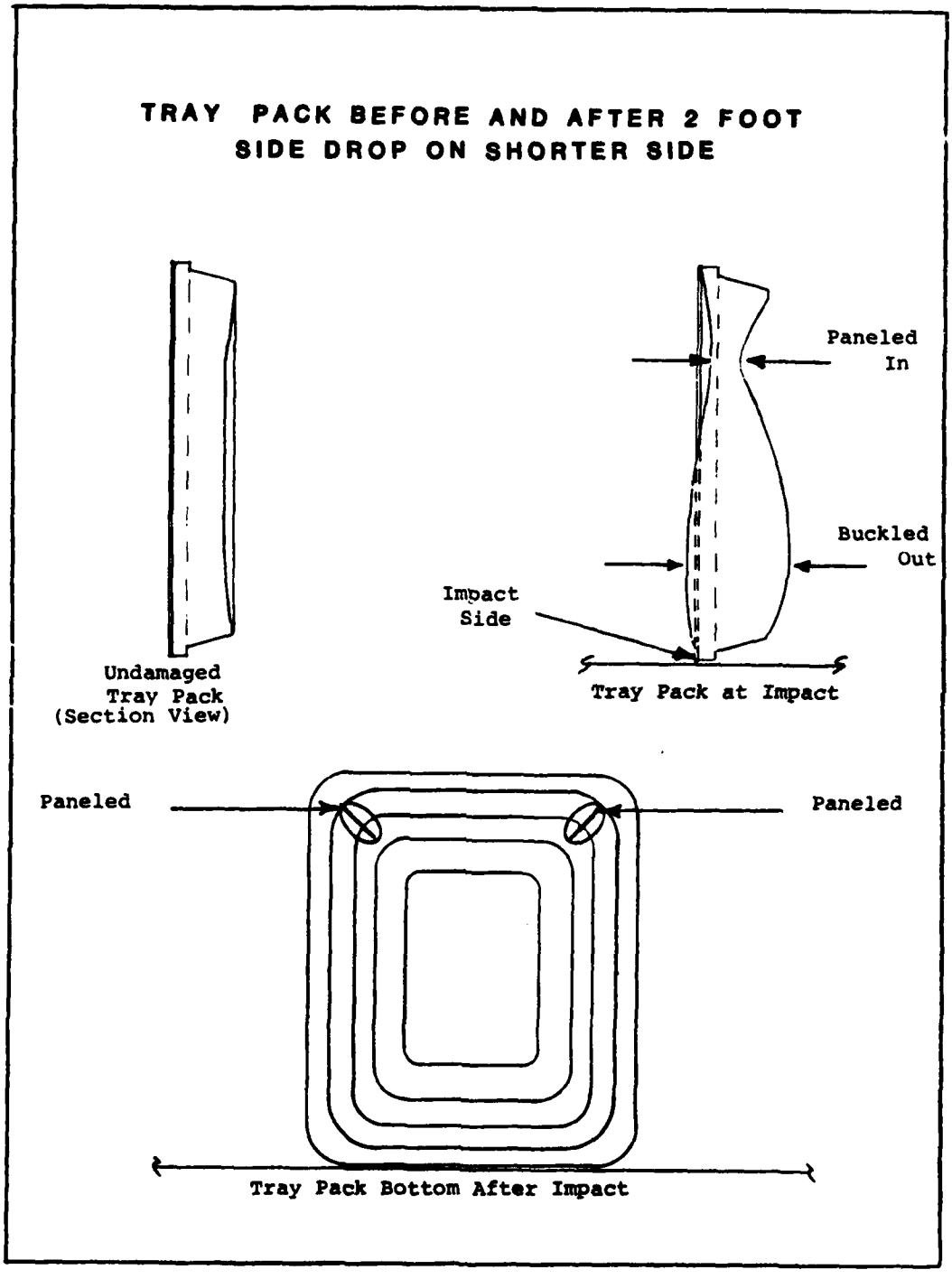


Figure 22. Tray Pack before and after 2-foot side drop on shorter side

To relate inches of mercury to inches dropped the relationship becomes: $h = 150 \left(\frac{\Delta P}{e}\right)$

where h is in inches height
ΔP is in inches Mercury
e is in pounds per cubic foot

Table 18 compares the drop height achieved without damage for a variety of samples tested. The results are very similar to the vacuum tests of Table 17. The level of reinforcement increases the drop height required to cause damage.

In addition to the Side Drop Testing shown in Table 18, we also side-drop tested some samples constructed of 90-pound material. Damage occurred to these samples at a drop height of 12" but to the top lid only. We dropped these samples from heights up to 21" without damaging the bottom of the Tray Packs, but at a drop height of 18" the lids were damaged so badly that opening would be impossible.

It is important to note the influence of vacuum in the Tray Pack on the drop height required for damage. We pressurized a baseline concept sample with air to pressure of 1" Hg. The sample was filled with 3.0 liters of water. Whereas damage to such a Tray Pack with no vacuum or pressure would occur at a drop of 6", the 1" pressure delayed paneling of the bottom to a drop height of 18 inches. With regard to buckling, the top lid of the Tray Pack was so badly damaged by the time a drop height 15" had been reached, that it would be impossible to open it.

Whereas a pressure increases the drop height to cause paneling of the bottom of the Tray Pack, a vacuum decreases the drop height and very much increases the susceptibility to damage. We performed a Side Drop Test on a Tray Pack of peas. It was very badly damaged with very deep panels in the bottom at a drop height of 6 inches. We were concerned about this and wondered why the peas had such a high susceptibility to this type of damage. Then we noticed that the Tray Packs with peas were

TABLE 18

TRAY PACK SIDE DROP HEIGHT REQUIRED TO DAMAGE
AS A FUNCTION OF SAMPLE CONFIGURATION
(EACH SAMPLE FILLED WITH APPROXIMATELY
3.0 LITERS OF MATERIAL)

SAMPLE CONFIGURATION	FOOD AND QUANTITY PACKED	DROP HEIGHT REQUIRED TO DAMAGE
BASELINE NO VACUUM	WATER 3.0 LITERS (6 lb 10 oz)	6"
BOTTOM CORNERS CROSS REINFORCED NO VACUUM	WATER 3.0 LITERS (6 lb 10 oz)	12"
BOTTOM REINFORCED ACROSS WIDTH TO WITHIN 3/4" OF EDGE NO VACUUM	WATER 3.0 LITERS	15"
TOP AND BOTTOM REINFORCED ACROSS WIDTH TO EDGE NO VACUUM	WATER 3.0 LITERS	18"

filled to 6 pounds 8 ounces and sealed under vacuum, whereas other foods were filled to 6 pounds 10 ounces and sealed under vacuum, while our water-filled test samples were filled with 3 liters (6 pounds 10 ounces) of water and sealed under atmospheric pressure. This 2-ounce extra vacuum void volume space makes these underfilled Tray Packs much more susceptible to damage.

It is the vacuum that causes the damage not the underfilling. We Side Drop Tested a number of baseline Tray Packs filled to varying degrees with water but with no vacuum and we found that the less fluid we put in the Tray Packs, the higher the drop height required to cause damage. See Table 19.

In summary we determined:

(1) That there is a relationship between the amount of vacuum sustainable by a Tray Pack without damage and the height of side drop sustainable without damage.

(2) That the basis of the ralationship is the hydrodynamic vacuum and pressure forces induced by the fluid packed and applied to the Tray Pack at the moment of drop impact.

(3) That the vacuum induced by underfilling and vacuum packing Tray Packs filled with peas makes them highly susceptible to damage.

(4) That underfilling Tray Packs without vacuum packing reduces susceptibility to damage.

(5) That reinforcing Tray Packs increases the side drop height required to cause damage.

(6) That 90-pound Tray Packs can survive a greater drop height without damage than the baseline Tray Packs, and that the bottoms of 90-pound Tray Packs are particularly resistant to side drop damage.

TABLE 19

TRAY PACK SIDE DROP HEIGHT REQUIRED TO DAMAGE
AS A FUNCTION OF FILL LEVEL

BASELINE UNREINFORCED TRAY PACKS
FILLED WITH WATER
NO VACUUM

QUANTITY PACKED	DROP HEIGHT REQUIRED TO DAMAGE
3.0 LITERS	6"
2.75 LITERS	9"
2.5 LITERS	12"
2.0 LITERS	18"
1.0 LITERS	OVER 18"

Shipping container side drop tests

During impact, shipping container material acts as a shock cushion to the Tray Packs enclosed. One way to improve the capability of Tray Packs to survive rough handling environments without damage is to improve the shock absorbing capabilities of the shipping containers. Consequently we devised a shipping container evaluation drop test to determine how much the baseline shipping container improved the ability of the Tray Packs to survive the shock of impact, and secondly to determine how much improvement over the baseline container would result by substituting new shipping container concepts with improved shock absorbing capabilities.

Since the Tray Packs have shown an extreme sensitivity to damage from side dropping, we felt that the shipping container evaluation drop test should be a side drop test.

The results of this testing are shown in Table 20. The first three tests were performed using baseline Tray Packs in three different shipping container concepts. We learned from this set of tests that:

(1) The baseline shipping container increases the side drop height required to damage the baseline Tray Pack from 6" to 10".

(2) The bundle concept shipping container increases the side drop height required to damage the baseline Tray Pack from 6" to 22".

The last three tests were performed using Tray Packs reinforced across the entire width of the top and bottom in the same three different shipping container concepts. From these three tests we learned that:

(1) The baseline shipping container increases the side drop height required to damage the reinforced Tray Pack from 18" to 22".

(2) The bundle concept shipping container increases the side drop height required to damage the reinforced Tray Pack from 22" to 28".

TABLE 20

SHIPPING CONTAINER SIDE DROP HEIGHT REQUIRED TO DAMAGE TRAY PACK CONTAINED

SHIPPING CONTAINER TYPE	TRAY PACK TYPE	DROP HEIGHT REQUIRED TO DAMAGE TRAY PACK
BASELINE	BASELINE	10"
FOAM PAD CONCEPT	BASELINE	10"
BUNCLE CONCEPT	BASELINE	22"
BASELINE	REINFORCED TOP AND BOTTOM ACROSS ENTIRE WIDTH	22" THIS DAMAGE IS NOT A PANEL AND IS VERY SLIGHT
BUNDLE CONCEPT	*REINFORCED TOP AND* BOTTOM ACROSS ENTIRE WIDTH	28"
FOAM PAD CONCEPT	REINFORCED TOP AND BOTTOM ACROSS ENTIRE WIDTH	MORE THAN 28" HOWEVER PADS MUST BE CHANGED AFTER DROP

It is worthwhile to note that the damage to the Tray Packs from these heights includes such things as forced leakage past the seal and buckling of the sides of the Tray Pack rather than paneling and buckling of the bottom and top. In other words damage from these heights is entirely different than what is happening to the baseline containers with a 10" shipping container side drop.

(3) The foam pad shipping container increases the side drop height required to damage the reinforced Tray Pack to some undetermined level above 28". However, the Tray Packs crush the foam pads during impact so that they are useless for further dropping.

Among the concepts that we did not test during the program that may have potential for improving Tray Pack durability are:

(1) A baseline shipping container (without corner blocks) in which the Tray Packs are bundled.

(2) A foam pad shipping container using resilient foam.

We learned a number of important facts during this sequence of three evaluation tests (vacuum, Tray Pack drop, shipping container drop) and these are summarized below.

(1) The 90-pound Tray Pack is a definite improvement over the baseline Tray Pack.

(2) The Tray Pack reinforced top and bottom across its entire width has superior side drop damage characteristics.

(3) The bundle concept has superior damage protection characteristics.

(4) Underfilling Tray Packs resulting in increased vacuum void volume seriously increases susceptibility to damage.

Shipping container crush testing

Shipping container crush tests were performed on both baseline and bundle concept containers. In these tests single shipping containers were subject to continuously increasing uniform loads until failure. There were three tests performed in all, two of them to failure.

In the first test a baseline shipping container was progressively loaded until the weight imposed reached 1184 pounds. Each addition of weight resulted in a little more compression but not in failure. The setup was left overnight and in the morning the container was found crushed.

In the second test an empty baseline shipping container was subjected to 268 pounds and left overnight. The second day it was subject to 556 pounds by adding weight and left overnight. The third day it was subject to 844 pounds and left overnight. In the morning it was found crushed.

In the third test a bundle concept shipping container was subjected to 364 pounds and left for over one month with no ill effects. A bundle concept shipping container at the bottom of a four-layer stack would be subject to approximately the weight of this test.

The design of Tray Pack shipping containers to resist crushing loads is an area that needs a lot more effort than we were able to provide under this program. However, we believe that we have learned some things from our effort and we have listed them below.

(1) We believe that the crush resistance of the shipping container could be increased by increasing the moment of inertia of the vertical walls (both container and liner). This could be accomplished by using either "A" type flute material (0.24" thick vs 0.19" for C flute) or by adding a second liner.

(2) ASTM recommended rough handling test procedure is to add the weight instantaneously then remove it in the crush test. We feel it is more germaine to the objectives of USANL to add the weight once per day over

a period of days until failure occurs or until the specified level has been reached.

Army stacking practice is to stack four unit loads high, each unit load weighs 1540 pounds (for the baseline concept). Assuming 12 cartons in a layer of a unit load and 4 layers per unit load, the weight on the lowest level shipping container is 475 pounds (for the baseline concept).

Based on our test results the shipping containers should have no problem with these loads. However, this conclusion does not account for the possibility of non-uniform loading or unbalanced loading or the weakening of the shipping container due to cold and moisture. We recommend a testing program for both shipping containers and unit loads with the following objectives.

(1) Determining the basic load carrying capability of the current configuration based on analysis or previous fiberboard testing.

(2) Determine the increase in buckling strength required to achieve the necessary load carrying capability.

(3) Test both shipping containers and unit loads; baseline and improved design by successively subjecting them to increasing loads over an extended period of time.

7. RESULTS OF ACCEPTANCE TESTS

The data sheets for this testing are presented in Appendix D. The Acceptance Tests conducted were:

(1) Shipping Container Drop Test
(2) Shipping Container Impact Test
(3) Shipping Container Loose Load Vibration Test
(4) Unit Load Drop Test
(5) Unit Load Crush Test

We had originally planned to conduct a unit load vibration test. However since there was no damage, of any type, caused by the shipping container loose load vibration test, we felt it pointless to conduct the unit load vibration test. Instead, we expanded the scope of the shipping container drop and impact tests to include heavyweight, reinforced Tray Packs. We recommend that vibration testing, of any sort, be deleted from future testing since we found that vibration plays no part in Tray Pack damage.

The damage caused by our testing includes damage to Tray Packs and damage to shipping containers. The two types of damage are discussed separately.

It is worth noting that damage to the Tray Packs was seldom so severe that the Tray Pack could not be used. That is, seldom was the damage severe enough to suspect leakage or to cause severe distortion of the container. Nevertheless, we have some concern about damage to the Tray Pack inner coating, which was not measured. We recommend that in future testing Tray Pack containers have measurements made on the inner liner to determine its integrity.

Damage to shipping container corners during drop tests was usually sufficient to seriously degrade the capability of the shipping container to bear a stacking load. We would like to point out that we did not see any of this type of damage during incoming inspection. Consequently, we believe that we should not be overly concerned about this type of damage.

Shipping container drop test and impact test

The shipping container drop test calls for dropping on top, bottom, corners, and edges of the shipping container; but never on the side. We believe that this is a deficiency of the drop test as prescribed by the ASTM Rough Handling Test Procedure - at least as far as testing Tray Packs is concerned.

The impact test, as we have developed for this program, is a side drop test. Therefore, the combination of the drop test and the impact test results in an impact of every type on the shipping container. Consequently, we have grouped the results of these two complementary and similar tests together.

Damage to shipping container

Typical damage to shipping containers is shown in Tables 21 and 22. The most prominent damage to shipping containers during drop tests was the crushing of the corners inward by 1" which occurred in both the baseline concept and bundle concept shipping containers. This damage results, in our opinion, in a serious loss of stacking strength or crush strength. We were unable to find a single instance of this damage during our inspection of shipments incoming from Vanee and Blue Star Packers. Consequently, we feel that this type of damage is not common and not a cause for concern.

Aside from crushing of the corners, damage to the rest of the baseline shipping container was slight both from drop tests and impact tests.

The most significant additional damage to the bundle concept shipping containers was crushing or compression of the corner pads and occasional buckling seams appearing on the shipping container side walls. It is not clear that this damage reduces the ability to absorb further dropping or impact damage. It does reduce the stacking compression strength of the shipping container.

Damage to Tray Packs

Damage to the Tray Packs during drop testing and impact testing is shown in Tables 23, 24, 25, and 26.

TABLE 21
SHIPPING CONTAINER DAMAGE
DUE TO DROP TESTS

SHIPPING CONTAINER TYPE	TYPICAL DAMAGE			
	SHIPPING CONTAINER	PADS	LINER	CORNER CUBES
BASELINE	ALL FOUR CORNERS CRUSHED IN 1"	SLIGHT INDENTING FROM TRAY-PACK TOPS	SLIGHT CRUSHING AT ALL FOUR BOTTOM CORNERS	N/A
BUNDLE	ALL FOUR CORNERS CRUSHED IN 1"	N/A	NO DAMAGE	BOTTOM CORNER PADS CRUSHED 0.16" TO 0.18" TOP PADS 0.04"

TABLE 22
SHIPPING CONTAINER DAMAGE
DUE TO IMPACT

SHIPPING CONTAINER TYPE	TYPICAL DAMAGE			
	SHIPPING CONTAINER	PADS	LINER	CORNER CUBES
BASELINE	SLIGHT INDENTS FROM SLINGS	SLIGHT INDENTS FROM TRAYPACK TOP & BOTTOM	SLIGHT INDENTS ON IMPACT END FROM TRAYPACK ENDS	N/A
BUNDLE	SLIGHT INDENTS FROM SLINGS - - - - - - OCCASIONAL BUCKLING OF SHIPPING CONTAINER WALLS	N/A	SLIGHT INDENTS AT IMPACT END FROM TRAYPACKS ENDS	IMPACT END CORNER PADS CRUSHED 0.15" OPPOSITE ENDS 0.10"

TABLE 23

DAMAGE TO BASELINE TRAY PACK

DURING DROP TESTING AND IMPACT TESTING

DROP TEST	BASELINE	BUNDLE
PEAS	DAMAGE ALL 4 TRAY PACKS	DAMAGE TO TOP OF BOTTOM TRAY PACK
WATER	NO DAMAGE	SLIGHT DAMAGE TO TOP CORNERS OF BOTTOM TRAY PACK
LASAGNA	NO DAMAGE	SLIGHT DAMAGE TO TOP AND BOTTOM TRAY PACKS TOP - BUCKLE BOTTOM - PANEL

IMPACT TEST	BASELINE	BUNDLE
PEAS	SEVERE DAMAGE ALL 4 TRAY PACKS	MODERATE DAMAGE TOP THREE TRAY PACKS
WATER	BULGE IN TOP CORNERS OF TRAY PACK	NO DAMAGE
LASAGNA	NO DAMAGE	NO DAMAGE

TABLE 24

DAMAGE TO HEAVYWEIGHT TRAY PACK

DURING DROP TESTING AND IMPACT TESTING

DROP TEST	BASELINE	BUNDLE
PEAS	SMALL PANELS ALL 4 TRAY PACKS	SLIGHT DAMAGE TOP OF BOTTOM TRAY PACK
WATER	SMALL BUCKLES TRAY PACK ONLY	SLIGHT DAMAGE TOP AND BOTTOM OF BOTTOM TRAY PACK
LASAGNA	NO DAMAGE	SLIGHT DAMAGE BOTTOM 3 TRAY PACKS

IMPACT TEST	BASELINE	BUNDLE
PEAS	SEVERE DAMAGE ALL 4 TRAY PACKS	SLIGHT DAMAGE TOP AND 3RD TRAY PACK BOTTOMS MODERATE, BOTTOM TRAY PACK BOTTOM
WATER	BUCKLE IN TOP CORNERS OF TOP TRAY PACK	NO DAMAGE
LASAGNA	NO DAMAGE	NO DAMAGE

TABLE 25

DAMAGE TO REINFORCED TRAY PACK

DURING DROP TESTING AND IMPACT TESTING

DROP TEST	BASELINE	BUNDLE
PEAS	DAMAGE TO SIDES	NO DAMAGE
WATER	NO DAMAGE	NO DAMAGE
LASAGNA	SMALL PANEL SECOND TRAY PACK ONLY	NO DAMAGE

IMPACT TEST	BASELINE	BUNDLE
PEAS	SLIGHT DAMAGE TO TOP AND 3RD TRAY PACK BOTTOMS	NO DAMAGE
WATER	NO DAMAGE	NO DAMAGE
LASAGNA	NO DAMAGE	NO DAMAGE

TABLE 26

DAMAGE TO HEAVYWEIGHT REINFORCED TRAY PACK DURING DROP TESTING AND IMPACT TESTING

DROP TEST	BASELINE	BUNDLE
PEAS	NO DAMAGE	NO DAMAGE
WATER	NO DAMAGE	NO DAMAGE
LASAGNA	NO DAMAGE	NO DAMAGE

IMPACT TEST	BASELINE	BUNDLE
PEAS	NO DAMAGE	NO DAMAGE
WATER	NO DAMAGE	NO DAMAGE
LASAGNA	NO DAMAGE	NO DAMAGE

Table 26 shows that the heavy weight reinforced Tray Pack passed all tests without any damage. It passed the tests both when packed in the baseline shipping container and the bundle shipping container. Consequently, we recommend this concept for further development.

Table 25 shows that the reinforced Tray Pack constructed from baseline weight material passed all tests when tested in the bundle concept shipping container. However, when tested in the baseline container the Tray Pack packed with peas sustained damage to the side walls. We believe this is due to extra vacuum created by underfilling of the peas, and we recommend that all Tray Packs be filled to 6 pounds 10 ounces henceforth. The rest of the testing resulted in slight to no damage to the Tray Pack when tested in the baseline container. Nevertheless, it is clear that the heavy weight reinforced concept is superior to the reinforced concept constructed of baseline weight materials.

Table 24 shows the damage to the heavyweight container. The results show severe damage to the Tray Packs packed with peas in the baseline shipping container and slight to moderate damage in the bundle shipping container. Please note that there was no damage to the side walls as occurred to the reinforced Tray Pack.

Table 23 shows the damage to the baseline Tray Pack container. Damage to the Tray Packs packed with peas was severe in the baseline shipping container and moderate in the bundle shipping container. This and other testing show that the bundle concept has the ability to reduce damage to the Tray Packs. Nevertheless, significant damage did occur to the baseline Tray Packs when packed in the bundle concept shipping container.

Further examination of Table 24 shows that when the heavyweight Tray Pack is packed in the bundle concept shipping container the damage is reduced from moderate to slight.

In summary, the test results show that reinforcing of the Tray Pack top and bottom prevent both top and bottom from paneling and bulging. The use of heavyweight material prevents buck-

ling of the side walls and also makes the Tray Pack more resistant to denting. The combination of heavyweight material and reinforcing results in a Tray Pack able to withstand both dropping and impact tests without damage.

We believe our testing has also shown that the bundle concept shipping container reduces the amount of damage to the Tray Pack such that damage to heavyweight Tray Packs is only slight. We have demonstrated that Tray Packs packed with peas to 6 pounds 8 ounces have a high susceptibility to damage. We believe this is caused by extra vacuum and stress induced by underfilling and then evacuating the container. We believe this susceptibility to damage can be reduced or eliminated by requiring that all containers be filled to maximum fill level.

Shipping container loose load vibration tests

Testing showed the occurrence of resonances at between 10 and 200 hertz frequency. There was considerable amplification of vibration amplitude between the top of the pallet and the top of the shipping container. At certain frequencies the shipping containers tended to wander over the surface of the pallet and in several instances had to be relocated to prevent them from falling off the edge.

Inspection showed not one single instance of any damage to either Tray Packs or shipping containers. Consequently, we do not believe vibration to be a source of damage, and we recommend that it be deleted from further testing.

Unit load crush tests

Standard practice in Army Warehouses is to stack unit loads four high. Each baseline shipping container and pallet weighs approximately 1540 pounds. A four high stacking load would be 4620 pounds on top of the first unit load. Each bundle concept unit load weights 910 pounds. A four-high stacking load would be 2730 pounds on top of the first unit load.

The ASTM testing procedure calls for instantaneous loading of the unit load within a space which is conditioned both in temperature and humidity. We chose, instead, to perform gradual loading of the unit load in a high-humidity environment since our objective is to determine whether or not it is safe to stack the unit loads rather than to compare the loading measurements to an arbitrary standard. We had found in our evaluation testing that a shipping container that would sustain an instantaneous load would fail under that load during continuous exposure. Moreover, we found that a container that would sustain a load in conditioned space would fail at higher humidity.

The results of the crush tests on the baseline shipping container unit load and the bundle concept shipping container unit load are presented in Tables 27 and 28.

Please note that there was no damage to the Tray Packs during this testing.

Baseline concept crush test results

We loaded the baseline unit load with 1437 pounds and left it over the long weekend. This weight is the approximate equivalent of a second unit load atop the first. At the end of 72 hrs. most carton exterior faces were showing a pronounced bulge. However, the cartons were carrying the load. What we did not realize at the time, which became apparent when we removed the load, was that the foot print of the pallet on top of the unit load was so arranged that the entire load was concentrated on half the carton side walls and in particular the external side walls rather than being distributed over all the side walls.

We then added about 760 pounds, which resulted in buckling

Unit load drop tests

Unit load drop tests did not result in any damage to the Tray Pack containers.

In testing of the unit load composed of baseline shipping containers, we determined that buckling of the side wall of the outside bottom tier shipping containers occurred. Upon inspection, we determined that the buckling was due to a mismatch in height between the shipping container and the liner.

The shipping container side wall buckled down to the liner height. Until the buckling occurred, the liner was carrying no load.

We recommend that the liner height match the inside height of the shipping container so that it carries its portion of the load without deflection of the side wall.

TABLE 27

BASELINE SHIPPING CONTAINER

UNIT LOAD CRUSH TEST RESULTS

DATE	HOURS ELAPSED	POUNDS LOAD	CRUSH DEFLECTION	COMMENTS
5/28	0	1437		INITIAL LOADING
5/31	72	1437	0.22"	MOST EXTERIOR CARTON FACES SHOW A PRONOUNCED BULGE
5/31	72	2197	0.38"	SOME CARTON EXTERIOR FACES HAVE BUCKLED
6/1	96	2197	0.50"	
6/1	96	3033	0.53"	
6/2	120	3033	0.63"	ALL EXPOSED SIDES ARE BULGED. MANY CARTON SIDE WALLS HAVE FAILED. THE TRAY PACKS ARE CARRYING THE LOAD. MANY STRAPS ARE ALMOST SLACK.
6/2	120	3793	0.72"	
6/3	144	3793	0.80"	
6/3	144	4553	0.88"	
6/4	168	4553	0.94"	DEFLECTION ON ONE SIDE AVERAGES 1⅛", OTHER SIDE 5/8". FOOT PRINT AND UNEVEN LOADING CAUSED BY PALLET QUITE NOTICEABLE.

TABLE 28

BUNDLE CONCEPT SHIPPING CONTAINER

UNIT LOAD CRUSH TEST RESULTS

DATE TIME	TIME ELAPSED	LOAD	CRUSH DEFLECTION	LOAD CONDITION COMMENTS
6/4/83 9:00	0	905	- -	INITIAL LOAD
6/6/83 9:00	48 HRS	905	0.13"	SUPPORTING LOAD WITHOUT PROBLEM
6/6/83 9:00	48 HRS	1817	0.22"	SUPPORTING LOAD WITHOUT PROBLEM
6/6/83 18:00	57 HRS	1817	0.33"	SIDE WALLS OF CONTAINERS BEGINNING TO BULGE
6/7/83 9:00	72 HRS	1817	0.38"	DEFINITE SIDE WALL BULGING
6/7/83 9:00	72 HRS	2725	0.42"	SIDE WALLS BULGING
6/7/83 18:00	81 HRS	2725	0.58"	SIDE WALLS BULGING
6/8/83 9:00	96 HRS	2725	0.67"	SIDE WALLS BULGING

of some of the exterior faces. By the time we reached 3033 pounds (the equivalent of 2 unit loads) and an elapsed time of 120 hours, all the exposed side walls were buckled and the entire stacking load was being carried by the Tray Packs. Actually the stacking load was being carried by the portion of the Tray Pack under the foot pad of the loading pallet. Moreover, the deflection was such that the loading pallet had acquired a decided list with the deflection on one side twice the deflection on the other.

We increased loading to 4553 pounds, the equivalent of 3 unit loads atop the first, or 4 high. At this point, with an elapsed time of 168 hours, deflection had increased to almost 1".

When we disassembled the unit load we verified the failure of the side walls and the fact that the Tray Packs were carrying the load.

We do not believe the Tray Packs should be permitted to carry the stacking load since additional stress in the metal and on the seal could shorten shelf life. Presuming this assertion to be correct, we believe that unit loads of baseline shipping container Tray Packs should not be stacked more than 2 high.

In order to stack them higher, the shipping container should be redesigned so that the side walls can carry the stacking load.

In the event that Tray Packs can be permitted to carry the load, we assert that the baseline Tray Pack shipping container design is incorrect for this purpose. The problem is that the pads between Tray Packs do not allow efficient transfer of the stacking load from one Tray Pack to the next, which leads to local pad deflections at load concentrations followed by listing of the stacked load. This problem would be present even if the Tray Packs were stacked without pads since the Tray Pack would locally deflect the lid of the next leading to the same type of list. Consequently, it may not be possible to reliably use Tray Packs for a load carrying device. Therefore, we recommend that the side walls be made stronger.

Bundle concept crush results

Since there are only 27 containers to the pallet in the

bundle concept, each unit load weighs only 913 pounds. We loaded the bundle concept unit load with 905 pounds, approximately the weight of one unit load. The load was carried without problem. After 48 hours we added 912 pounds. At this point definite signs of bulging occurred. However, none of the shipping containers buckled. At the end of 72 hours we added another 912 pounds, the equivalent of 3 unit loads, atop the first. At the end of 96 hours all the side walls were bulging.

There was some listing of this unit load but it was less than ¼". All sides of the unit load seemed to be deflecting equally. Comparison of Table 27 and 28 shows that the amount of deflection per unit weight was just about equal for the two unit loads.

The reason for the more uniform settling lies in the configuration of the bundle concept. The corner pads immediately transmit stacking load to the Tray Packs, and there are no corner pads between the Tray Packs to buckle. Moreover, the Tray Packs are bound tightly together preventing selective buckling of the Tray Pack lids.

In addition, the bundle concept shipping container array with nine containers to the unit load matches the foot print of the three-stringer pallet bottom better than the 12-container array of the baseline shipping container.

Nevertheless, we do not recommend stacking the bundle concept more than two high. We also note our concern that any deflection of the shipping container results in load being applied to the Tray Packs.

In our opinion the side walls of this container also need to be made stronger.

8. CONCLUSIONS

Tray Pack conclusions

We have learned the Tray Packs as now constructed sustain regular damage to their lids and bottoms in the form of buckling of the lids and paneling of the bottoms. We have learned that the side walls of Tray Pack bottoms sustain buckling damage during drop and impact and that Tray Pack bottoms regularly sustain denting damage during handling in the plant.

We have learned that paneling and buckling damage to the bottoms and lids is caused by the vacuum imposed during packing of the food and by the hydrodynamic forces imposed by the food on the Tray Pack during moments of impact. We have learned that underfilling the Tray Pack container leads to excessive vacuum within the container and markedly increases the susceptibility to damage.

We have learned that Tray Packs, in large numbers, are received from the packer whose bottoms are covered with dents. These Tray Packs are packaged in completely undamaged shipping containers. Therefore, the damage occurs in the packer's plant, not during shipment. We do not know how much this denting reduces Tray Pack shelf life.

We have learned that the denting damage just mentioned and other damage as well is markedly reduced by the use of 90-pound material for the bottom and lid.

We have learned that the bundle concept shipping container reduces the amount of damage sustained by Tray Packs during drop and impact.

We have learned that the heavyweight reinforced Tray Pack concept passes all drop and impact Acceptance Tests without the slightest damage.

Shipping container conclusions

We have learned that the bundle concept shipping container, while possessing improved shock absorption characteristics, is cumbersome to pack.

We have learned that variances in the size of shipping containers lead to loose packing of Tray Packs and greater susceptibility to damage.

We have learned that a mismatch between shipping container size and liner size significantly reduces stacking strength.

We have learned that neither the baseline concept shipping container nor the bundle concept shipping container is strong enough to bear the compressive load created by stacking Tray Pack unit loads four high. In the case of the baseline Tray Pack shipping container this has four causes --

(1) Mismatch in height between the carton and the liner.
(2) Non-uniform shipping container loading via the pallet foot print.
(3) The inability of the design configuration to uniformly transfer load from the shipping container to the Tray Packs.
(4) The basic lack of strength of the shipping container and liner walls to bear so heavy a non-uniform load as is applied during stacking.

In the case of the bundle concept shipping container we have learned that not only are the walls not strong enough but that any deflection of them results in load being transmitted through the Tray Packs, which may shorten their shelf life.

10. RECOMMENDED FURTHER WORK

We recommend a second round of design, fabrication, and testing.

Tray Pack

We recommend the development of the heavyweight reinforced Tray Pack.

We recommend an investigation to determine the cause of Tray Pack denting at the packer's plant.

We recommend a determination of the impact of these dents on shelf life.

Shipping container

We recommend development of a shipping container that can easily bear the crush load created by stacking unit loads four high. This shipping container should be easily packed, have improved shock absorbing capabilities, and should bear the stacking load without transferring it to the Tray Packs.

Testing

We recommend that future testing include evaluation of the impact of Tray Pack damage on Tray Pack shelf life.

We recommend that vibration testing be deleted from future testing.

We recommend the future drop testing include drops on the sides of the shipping containers.

We recommend that future unit load compression tests be conducted by the addition of weight over an extended period rather than instantaneous loading and unloading.

We suggest a rough handling testing program restricted to:

(1) Tray Pack evaluation side drop tests.
(2) Shipping container evaluation side drop tests.
(3) Shipping container evaluation crush tests.
(4) Shipping container acceptance drop tests modified to include side drop.
(5) Unit load acceptance crushing tests conducted according to our procedure of the slow addition of weight over a period of days.

9. RECOMMENDATIONS FOR IMMEDIATE ACTION

Tray Pack

We recommend that henceforth all Tray Packs used by the Army be constructed of 90-pound material.

We recommend that henceforth all Tray Packs used by the Army be filled to maximum-fill capacity.

Shipping container

We recommend that a not-to-exceed dimension of 8 5/8" be specified for the shipping container carton inside height to assure that Tray Packs are not packed loosely in their cartons.

We recommend that the shipping container liners be specified to have a line-to-line contact (no looseness) to the shipping container carton top and bottom.

Unit loads

We recommend that unit loads not be stacked more than two high.

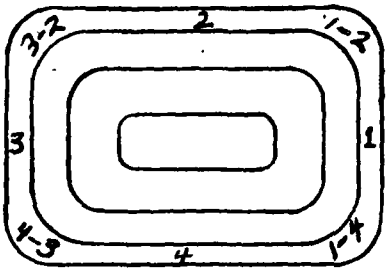
APPENDIX A

TRAY PACK INCOMING INSPECTION REPORTS

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX

2/9/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

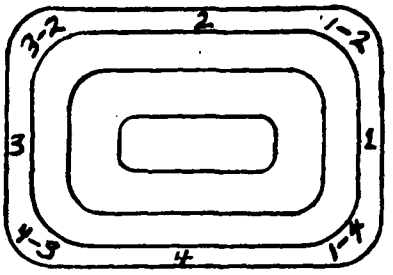
■ - CORNER PANEL

BASELINE LASAGNA TRAY PACKS

TRAY PACK#	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
1	⊠				X		X	X
2					X		X	
3			⊠		X		X	
4			⊠	⊠	X		O	
5					X			
6	⊠		⊠		X			
7	⊠			⊠	X	O		
8			⊠		O	X		X
9				■	X	O	O	O
10					X		X	
11		⊠					X	
12					X			
13				⊠	O			X
14					X			
15						X	O	
16				⊠	O		O	O

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 2/9/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

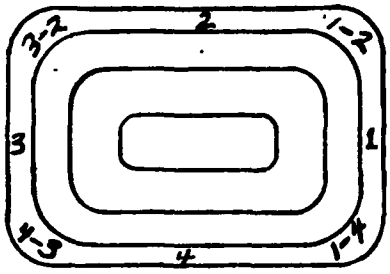
■ - CORNER PANEL

BASELINE LASAGNA TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
17								X
18						O	O	
19	⊠		⊠	⊠			X	
20					O		O	X
21			■		O	O	O	X
22			■		X	X	O	
23				⊠	O		O	
24					O	X	O	
25			⊠		X		X	
26			⊠			O	O	
27		⊠					O	
28						X	O	
29					O	O	O	O
30	⊠			⊠	O		O	X
31		⊠			O		O	
32					O	O		O

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 2/9/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

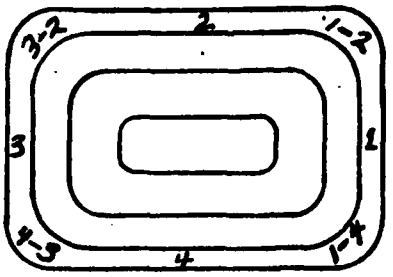
■ - CORNER PANEL

BASELINE LASAGNA TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
33	⊠				O		O	
34					O	O	O	O
35						O	O	O
36	⊠							O
37							O	O
38	⊠						O	
39					O	O	O	O
40					O		O	
41					O		O	
42				■	X			
43					O		O	
44			■		O	O	O	
45					O	O	O	
46						O	O	
47					O		O	
48					O	O		

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 2/9/93

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

▣ - INCIPIENT CORNER PANEL

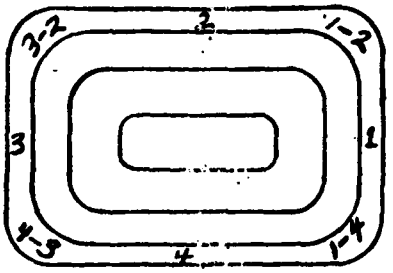
■ - CORNER PANEL

BASELINE LASAGNA TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
49	▣					O		O
50					O			
51	▣					O	O	O
52				■	O			
53	■				O		O	
54					X	X		
55	■				O			
56	■				O	O		
57			▣		X		O	
58	▣				O		O	
59				■	O			O
60		■				O	O	
61			■		O			
62		■	■		O			
63					O		O	
64			■		X		O	

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 2/9/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

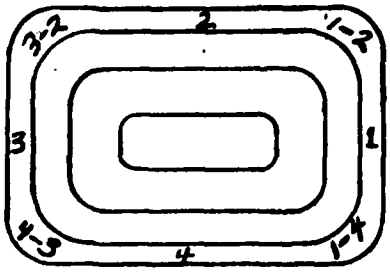
■ - CORNER PANEL

BASELINE LASAGNA TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
65		⊠			X		O	
66	⊠	⊠		■				
67				⊠	O	X	O	
68					O		O	O

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 3/14/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

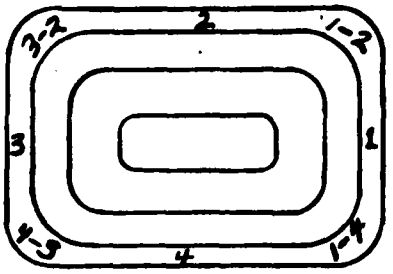
■ - CORNER PANEL

BASELINE PEAS TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
1			■		O			O
2						O		X
3			■					
4						X		X
5								X
6	■			■				
7							O	
8						X		X
9						X		O
10	⊠							
11						O	O	
12	⊠		⊠		O			
13						O		O
14	⊠							
15		⊠	⊠		O	O		
16					O	O		O

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 3/14/93

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

▣ - INCIPIENT CORNER PANEL

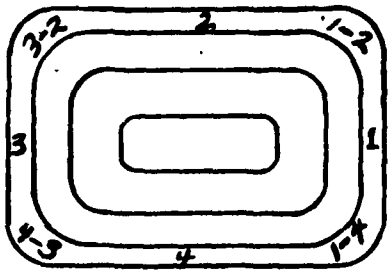
■ - CORNER PANEL

BASELINE PEAS TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
17						O		O
18								O
19	■	▣					O	
20							X	
21						O	O	
22								O
23	▣				O			
24								O
25					O			
26					O	O		
27					O			
28	▣							
29		▣						
30	▣				X			
31						O	O	O
32			▣					

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 3/14/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

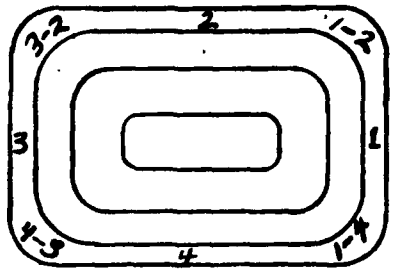
■ - CORNER PANEL

BASELINE PEAS TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
33	⊠	⊠						
34	⊠				O			
35								O
36		⊠						
37				⊠				
38	■			■				
39	■						O	
40			■		X			
41			■					
42	⊠		■	■				
43	⊠							
44							X	
45				⊠				
46					BOTTOM Not @ Edge			
47			⊠					
48					Top Edge		Dent	#1

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 3/14/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

▣ - INCIPIENT CORNER PANEL

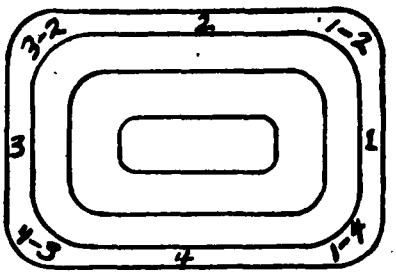
■ - CORNER PANEL

BASELINE PEAS TRAY PACKS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
49					Top surface dent			
50	■		■					
51	■			■		X		
52					O	O		O
53						O	O	O
54	▣		▣					
55			▣					
56						O	O	
57						O	O	
58					O	O		O
59						X		
60						X		
61					X	X	X	X
62					O			
63						O	O	

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 6/7/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

▩ - INCIPIENT CORNER PANEL

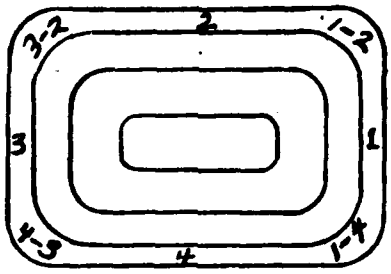
■ - CORNER PANEL

HEAVYWEIGHT TRAY PACKS - LASAGNA

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
1							O	
2						O		
3					O		O	
4					O		O	
5					O		O	
6					O			
7					O		O	
8					X		O	
9					O		O	
10							O	
11					X		O	
12					O		O	
13					O		O	
14					O		O	
15					O		O	
16					O		O	

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 5/7/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

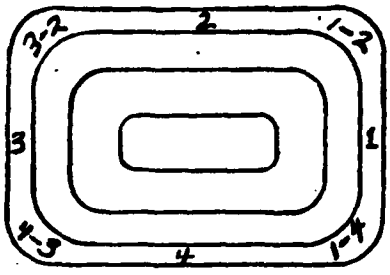
■ - CORNER PANEL

HEAVYWEIGHT TRAY PACKS - LASAGNA

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
17					O		O	
18				⊠			O	X
19					O		O	
20					O		O	
21							O	
22					O		O	
23					O		O	

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 3/14/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

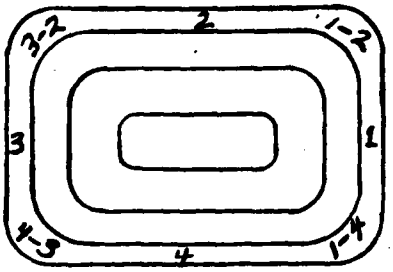
■ - CORNER PANEL

HEAVYWEIGHT TRAY PACKS - PEAS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
1					X	X		
2						O		
3		⊠		⊠			O	
4				⊠				
5	⊠							
6					O			
7								O
8					X		O	
9					O		O	
10				⊠				
11					O		O	
12				⊠				
13					O		O	
14	⊠		⊠	⊠				
15						O		
16					O			

INCOMING INSPECTION TRAY PACK DAMAGE MATRIX 3/14/83

KEY:



TRAY PACK BOTTOM

X - DENT

O - SLIGHT DENT

⊠ - INCIPIENT CORNER PANEL

■ - CORNER PANEL

HEAVYWEIGHT TRAY PACKS - PEAS

TRAY PACK #	CORNER PANELS				BOTTOM EDGE DENTS			
	1-2	1-4	4-3	3-2	1	2	3	4
17					O		O	O
18	⊠	⊠		⊠				
19						O		O
20		⊠	■					
21	⊠							
22	⊠							
23						X		
24						X		X
25							O	

APPENDIX B
TRAY PACK TEST CARTON SIZING

The sizes of the various test cartons were derived in the following manner.

(1) BUNDLE CONCEPT WITH BASELINE TRAY PACKS

A bundle consisting of 4 baseline Tray Packs, 8 baseline pads and 1 baseline tube (sleeve) was measured equal to:

12 5/8"L x 10 3/8w x 8 11/16D

To arrive at the inside dimensions of the carton we must add 1" for the thickness of each foam pad and 0.15" for the thickness of each layer of V3c material (pad backing).

Bundle	=	12.625L x	10.375W x 8.688D
+ 2 Foam Pads		2.000	2.000 2.000
+ Layers V3c		.300	.300 .300
Carton Dimensions		14.925L x	12.675W x10.988D

or for dimensions fractionally the carton inside is:

14 15/16"L x 12 11/16W x 11"D

(2) THE BUNDLE CONCEPT WITH REINFORCED TRAY PACKS

When reinforced Tray Packs are used, the bundle becomes taller. The increase in height varies, as the glue beads and metal work on the Tray Pack's reinforcement is difficult to control.

Actual measurement of reinforced Tray Pack bundles shows the increase to be 5/8". Variations from this value can be adjusted by trimming glue beads and addition of pads. Length and width dimensions remain unchanged as nothing is done to the Tray Pack to alter them. The resultant carton depth is 11" + 5/8" or 11 5/8". The carton inside dimensions are:

14 15/16"L x 12 11/16"W x 11 5/8"D

(3) THE BASELINE CARTON

The baseline carton by actual measurement varies depending on whose it is. Cartons from Natick Labs measure out as*

Carton - 13"L x 10 13/16W x 9"D
Tube - 12 7/16L x 10 3/8W x 8 11/16D
Pad - 12 7/16L x 10 1/8W

Cartons from Vanee measure out as*:

Carton - 12 11/16L x 10 7/16W x 8 7/8D
Tube - 12 1/4L x 10 1/16W x 8 5/8D
Pad - 12 1/4L x 9 15/16W

Cartons from Blue Star measure out as*:

Carton - 12 27/32L x 10 5/8W x 9 1/8D
Tube - 12 11/16L x 10 11/32W x 9D
Pad - 12 1/4" x 10"

* Inside Dimensions

(4) THE BASELINE REINFORCED CARTON

Assuming the Vanee carton to be the best and a 5/8" height increase for reinforcement the resultant inside dimensions are:

12 11/16L x 10 7/16"W x 9½"D

(5) REINFORCED TRAY PACK TUBES

Assuming the Vanee sleeve to be the best and a 5/8" height increase for reinforcement the resultant inside dimensions are:

12 1/4"L x 10 1/16"W x 9 1/4"D

(6) Pads sized from the Vanee shipment will be assummed to be the best size

12 1/4"L x 9 15/16"W

(7) Tubes sized from the Vanee shipment will be utilized on both baseline and bundle cartons with baseline Tray Packs. The apparent difference in height between a baseline stack (4 Tray Packs plus 5 pads) and a bundle stack (4 Tray Packs plus 8 pads) is 0.45". Comparisons of loose stacks in baseline configuration (4 Tray Packs, 5 pads) and strapped stacks in bundle configuration (4 Tray Packs 8 pads) show only 1/16" difference in height (the bundle is taller). This difference is not sufficient to justify changing the (sleeve) tube height. Thus only two tubes are required; one for all baseline Tray Pack applications and one for all reinforced Tray Pack applications.

Baseline Tube -

12 1/4"L x 10 1/16"W x 8 5/8"D

SUMMARY

ITEM	INSIDE DIMENSIONS	NO. REQUIRED	SOURCE
BASELINE CARTON	12 11/16"L x 10 7/16"W x 8 7/8"D	44	Vanee
BASELINE T.P. TUBE	12 1/4"L x 10 1/16"W x 8 5/8"D	70	Vanee
BASELINE PAD	12 1/4"L x 9 15/16"W	500	Horn
BUNDLE BASELINE CARTON	14 15/16"L x 12 11/16"W x 11"D	50	Horn
BUNDLE REINFORCED CARTON	14 15/16"L x 12 11/16"W x 11 5/8"D	50	Horn
BASELINE REINFORCED CARTON	12 11/16"L x 10 7/16"W x 9 1/2"D	50	Horn
REINFORCED T.P. TUBES	12 1/4"L x 10 1/16"W x 9 1/4"D	50	Horn

APPENDIX C

TRAY PACK EVALUATION TEST DATA

SAMPLE #	TEST TYPE	SAMPLE TYPE
1	Vacuum	Baseline
2	"	"
3	"	"
4	"	"
8	"	"
9	"	Cross reinforced bottom corners
10	"	"
22	"	Entire bottom reinforced to within 3/4" of edge
25	"	Entire top & bottom reinforced to edge
5	Side Drop	Baseline - 3 liters water
6	"	"
7	"	"
11	"	Cross reinforced bottom corners
12	"	" " " "
13	"	" " " "
14	"	" " " "
15	"	" " " "
16	"	Baseline
17	"	Baseline - 2 liters water
18	"	Baseline - 1 liter water
19	"	Baseline - 3 liters water pressurized to 1" hg
20	"	Baseline - 2.5 liters water
21	"	Baseline 2.75 liters water
23	"	Entire top and bottom reinforced to within 3/4" of edge
24	"	Entire top and bottom reinforced to edge
26	"	Entire top and bottom reinforced to edge
27	"	Heavyweight - 3 liters water
28	"	" " " "
29	"	" " " "
30	"	Baseline Peas
31	Shipping Container Side Drop	Baseline
32	"	Foam Pad
33	"	Bundle concept
34	"	Baseline with reinforced* Tray Pack *(Entire top & bottom full width)
35	"	Bundle with reinforced* Tray Pack
36	"	Foam pad with reinforced* Tray Pack
37	"	Baseline with bundle straps
38	"	Baseline with bundle straps
39	"	Bundle

TRAY PACK TESTS

SAMPLE NUMBER: 1 DATE: 8/6/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: UNREINFORCED

TEST LEVEL VACUUM	PANEL		COMMENT
	YES	NO	
2.5" Hg	X		TRAY PACK BOTTOM DEEP INDENT PANELS 2 DIAGONALLY OPPOSITE CORNERS

TRAY PACK TESTS

SAMPLE NUMBER: 2 DATE: 8/6/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: UNREINFORCED

TEST LEVEL VACUUM	PANEL		COMMENT
	YES	NO	
2.0" Hg	X		TRAY PACK BOTTOM DEEP INDENT PANEL 1 CORNER

TRAY PACK TESTS

SAMPLE NUMBER: 3 DATE: 8/6/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: UNREINFORCED

TEST LEVEL VACUUM	PANEL		COMMENT
	YES	NO	
1.8"	X		TRAY PACK BOTTOM DEEP INDENT PANELS 2 DIAGONALLY OPPOSITE CORNERS

TRAY PACK TESTS

SAMPLE NUMBER: 4 DATE: 8/6/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: UNREINFORCED

TEST LEVEL VACUUM	PANEL		COMMENT
	YES	NO	
1.3" Hg		X	
1.6"		X	
1.8"		X	
2.0"		X	
2.3"		X	
2.5"	X		DEEP INDENT PANELS DIAGONALLY OPPOSITE CORNERS TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 8 DATE: 9/20/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS
2 REINFORCEMENTS AT EACH CORNER

TEST LEVEL VACUUM	PANEL		COMMENT
	YES	NO	
1.25" Hg		X	
1.50" Hg		X	
1.80		X	
2.00		X	
2.50	X		(SUPPORT BROKE FREE) TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 9 DATE: 9/22/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS
2 REINFORCEMENTS

TEST LEVEL VACUUM	PANEL YES	PANEL NO	COMMENT
2.5" Hg	X		SUPPORTS BROKE LOOSE TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 10 DATE: 9/23/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS
2 REINFORCEMENTS

TEST LEVEL VACUUM	PANEL		COMMENT
	YES	NO	
1.00" Hg		X	
2.00" Hg		X	
2.00" Hg	X		ONE PIECE POPPED OFF TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 22 DATE: 10/1/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: BOTTOM SURFACE REINFORCED ACROSS WIDTH TO WITHIN 3/4" OF EDGE

TEST LEVEL			PANEL		COMMENT
"	H20	"Hg	YES	NO	
35.5	0	0			START
40.5	10	.74		X	NO REACTION
45.5	20	1.47		X	
51.0	31	2.28		X	
55.	39	2.87		X	
58.	45	3.31"	X		VERY CONTROLLED PANEL

TRAY PACK TESTS

SAMPLE NUMBER: 25 DATE: 10/12/82

TEST TYPE: VACUUM

SAMPLE CONFIGURATION: LATERAL REINFORCED TOP AND BOTTOM ENTIRE WIDTH TO EDGE

TEST LEVEL			PANEL		COMMENT
	"H2O	"Hg	YES	NO	
35.5	0	0		X	ZERO VACUUM
40.75	10.5	.77		X	
45.75	20.5	1.51		X	
51	32.5	2.39		X	
55	39.0	2.87		X	
60.5	50.0	3.68		X	
63.5	56.0	4.12	X		SINGLE CORNER PANEL VERY SLIGHT AND CONTROLLED
					TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 5 DATE: 8/9/82

TEST TYPE: DROP

SAMPLE CONFIGURATION: UNREINFORCED

3 LITERS OF WATER

TEST LEVEL	PANEL		COMMENT
	YES	NO	
3" DROP		X	NO DAMAGE
6" DROP	X		INDENT AT CAN BOTTOM OPPOSITE IMPACT EDGE. BULGE AT CAN TOP AT IMPACT EDGE.

TRAY PACK TESTS

SAMPLE NUMBER: 6 DATE: 8/16/82

TEST TYPE: DROP

SAMPLE CONFIGURATION: UNREINFORCED

3 LITERS OF WATER

TEST LEVEL	PANEL		COMMENT
	YES	NO	
3" DROP		X	NO DAMAGE
4" DROP	X		INDENT PANEL IN CAN BOTTOM AT EDGE OPPOSITE IMPACT BOTH SIDES

TRAY PACK TESTS

SAMPLE NUMBER: 7 DATE: 8/16/82

TEST TYPE: DROP

SAMPLE CONFIGURATION: UNREINFORCED

3 LITERS OF WATER

TEST LEVEL	PANEL		COMMENT
	YES	NO	
3" DROP		X	NO DAMAGE
6" DROP	X		INDENT PANEL IN CAN BOTTOM AT EDGE OPPOSITE IMPACT. BULGE BUCKLE IN CAN LID AT IMPACT EDGE.

TRAY PACK TESTS

SAMPLE NUMBER: 11 DATE: 9/23/82

TEST TYPE: DROP

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS

2 REINFORCEMENTS

3 LITERS OF WATER

TEST LEVEL	PANEL		COMMENT
	YES	NO	
3"		X	2 SUPPORTS BROKE OFF TRAY PACK BOTTOM
6"	X		SUPPORTS BROKE OFF TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 12 DATE: 9/23/82

TEST TYPE: DROP

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS
2 REINFORCEMENTS
3.0 LITERS OF WATER

TEST LEVEL	PANEL		COMMENT
	YES	NO	
6"	TOP LID BUCKLE	X BOTTOM	BOTTOM OPPOSITE IMPACT EDGE NO PANEL--SUPPORTS HELD
			SUPPORTS BROKE OFF AT IMPACT EDGE
			BULGE BUCKLE TOP LID

TRAY PACK TESTS

SAMPLE NUMBER: 13 DATE: 9/23/82

TEST TYPE: DROP

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS

2 REINFORCEMENTS

3.0 LITERS OF WATER

TEST LEVEL	PANEL		COMMENT
	YES	NO	
9"		X	BOTTOM OPPOSITE IMPACT EDGE NO PANEL SUPPORTS HELD, BULGE BUCKLE AT IMPACT EDGE IN TRAY PACK LID

TRAY PACK TESTS

SAMPLE NUMBER: 14 DATE: 9/27/82

TEST TYPE: DROP - 3.0 LITERS WATER

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS
2 REINFORCEMENTS

TEST LEVEL	PANEL		COMMENT
	YES	NO	
12"	X		BOTTOM OPPOSITE IMPACT EDGE PANELED ON ONE SIDE WHERE REINFORCEMENTS CAME OFF. DID NOT PANEL ON OTHER SIDE WHERE REINFORCEMENTS STAYED, TWO BULGE BUCKLES TOP LID AT IMPACT EDGE.

TRAY PACK TESTS

SAMPLE NUMBER: 15 DATE: 9/27/82

TEST TYPE: DROP 3.0 LITERS WATER

SAMPLE CONFIGURATION: CROSS REINFORCED AT BOTTOM CORNERS

2 REINFORCEMENTS

TEST LEVEL	PANEL		COMMENT
	YES	NO	
15"	X	X	PANELED ON ONE SIDE WHERE REINFORCEMENTS CAME OFF, TRAY PACK BOTTOM OPPOSITE IMPACT EDGE DID NOT PANEL ON OTHER SIDE WHERE REINFORCEMENTS STAYED, TRAY PACK BOTTOM. OPPOSITE IMPACT EDGE.

TRAY PACK TESTS

SAMPLE NUMBER: 16 DATE: 9/27/82

TEST TYPE: DROP - 3.0 LITERS WATER

SAMPLE CONFIGURATION: UNREINFORCED SAMPLE

TEST LEVEL	PANEL		COMMENT
	YES	NO	
6"		X	BULGE TOP LID
9"	X		PANELED ON BOTH EDGES TRAY PACK BOTTOM OPPOSITE IMPACT EDGE

TRAY PACK TESTS

SAMPLE NUMBER: 17 DATE: 9/27/82

TEST TYPE: DROP - 2.0 LITERS WATER

SAMPLE CONFIGURATION: UNREINFORCED SAMPLE

TEST LEVEL	PANEL		COMMENT
	YES	NO	
6" DROP		X	NO PANEL - NO BULGE
9"		X	NO PANEL - SLIGHT BULGE IN TOP LID AT IMPACT EDGE
12"		X	NO PANEL - 2 BULGES IN TOP LID AT IMPACT EDGE
15"		X	NO PANEL - 2 BULGES IN TOP LID AT IMPACT EDGE
18"	X		SLIGHT PANEL IN BOTTOM OPPOSITE IMPACT EDGE BULGE OUT AT IMPACT EDGE BOTTOM, BOTH CORNERS

TRAY PACK TESTS

SAMPLE NUMBER: 18 DATE: 9/27/82

TEST TYPE: DROP - 1.0 LITERS WATER

SAMPLE CONFIGURATION: UNREINFORCED SAMPLE

TEST LEVEL	PANEL		COMMENT
	YES	NO	
6"		X	NO PANEL , NO BULGE
9"		X	NO PANEL , SLIGHT BULGE ONE SIDE, TOP LID AT IMPACT EDGE
12"		X	NO PANEL, SLIGHT BULGE 2 SIDES, TOP LID AT IMPACT EDGE
15"		X	NO PANEL , BULGE 2 SIDES TOP LID IMPACT EDGE
18"		X	NO PANEL , BULGE 2 SIDES BOTTOM DENTED FROM IMPACT. TOP LID IMPACT EDGE

TRAY PACK TESTS

SAMPLE NUMBER: 19 DATE: 9/27/82

TEST TYPE: DROP - 3.0 LITERS WATER

SAMPLE CONFIGURATION: UNREINFORCED SAMPLE
PRESSURIZED TO 1" Hg

TEST LEVEL DROP	PANEL		COMMENT
	YES	NO	
			SAMPLE BULGED TOP AND BOTTOM BEFORE TESTING NO PANELING OR BULGE BUCKLES
6"		X	NO PANELING OF BOTTOM BUT BULGE BUCKLES AT IMPACT EDGE TOP OF CONTAINER
9"		X	NO PANELING OF BOTTOM BUT TOP OF CONTAINER HAS BAD BULGE BUCKLES AT IMPACT EDGE
12"		X	BULGE BUCKLES AT BOTTOM SURFACE AT IMPACT EDGE
15"		X	FRONT OF CAN PRACTICALLY DESTROYED BY BULGE BUCKLE
18"	X		SMALL PANEL AT LEFT CORNER CAN BOTTOM OPPOSITE IMPACT EDGE
21"	X		PANELS ON BOTH UPPER CORNERS OF CAN BOTTOM OPPOSITE IMPACT EDGE

TRAY PACK TESTS

SAMPLE NUMBER: 20 DATE: 9/27/82

TEST TYPE: DROP - 2.5 LITERS WATER

SAMPLE CONFIGURATION: UNREINFORCED SAMPLE

TEST LEVEL DROP	PANEL		COMMENT
	YES	NO	
6"		X	TRAY PACK BOTTOM NO PANEL -- ONE SMALL BULGE TOP, ONE SIDE
9"		X	BOTTOM NO PANEL -- 2 BULGES TOP EACH SIDE
12"	X		SMALL PANEL EACH SIDE OF BOTTOM OPPOSITE IMPACT EDGE
15"	X		PANEL DEEPENED BUT STILL SMALL
18"	X		PANEL IN OPPOSITE IMPACT EDGE - BOTTOM BULGE BOTH SIDES OF IMPACT EDGE

TRAY PACK TESTS

SAMPLE NUMBER: 21 DATE: 9/27/82

TEST TYPE: DROP - 2.75 LITERS WATER

SAMPLE CONFIGURATION: UNREINFORCED SAMPLE

TEST LEVEL DROP	PANEL		COMMENT
	YES	NO	
6"		X	NO PANEL -- 2 BULGES TRAY PACK BOTTOM
9"	X		PANEL BOTH SIDES TRAY PACK BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 23 DATE: 10/2/82

TEST TYPE: DROP - 3 LITERS WATER

SAMPLE CONFIGURATION: REINFORCED TOP AND BOTTOM ACROSS WIDTH TO WITHIN 3/4" OF EDGE

TEST LEVEL DROP	PANEL		COMMENT
	YES	NO	
15"	X		TRAY PACK BOTTOM PANELS IN TWO LOCATIONS OPPOSITE IMPACT EDGE AND BULGE/BUCKLED AT IMPACT EDGE BOTH TOP AND BOTTOM. NEVERTHELESS PANELS WERE NOT VERY DEEP AND DID NOT PENETRATE PAST OUTER EDGE OF CAN.

TRAY PACK TESTS

SAMPLE NUMBER: 24 DATE: 10/4/82

TEST TYPE: DROP - 3 LITERS WATER

SAMPLE CONFIGURATION: CROSS REINFORCED BOTTOM EDGE
ENTIRE WIDTH TO EDGE

TEST LEVEL DROP	PANEL		COMMENT
	YES	NO	
15"		X	NO PANEL ON BOTTOM
18"		X	SMALL BULGE BUCKLE AT IMPACT EDGE ON BOTTOM
21"		X	SMALL BULGE BUCKLE ON OTHER SIDE ON BOTTOM

TRAY PACK TESTS

SAMPLE NUMBER: 26 DATE: 10/14/82

TEST TYPE: DROP - 3 LITERS WATER

SAMPLE CONFIGURATION: LATERAL REINFORCED TOP AND BOTTOM ENTIRE WIDTH TO EDGE

TEST LEVEL DROP	PANEL		COMMENT
	YES	NO	
15"		X	SLIGHT BULGE AT IMPACT BOTTOM EDGE, ONE SIDE
18"	X		SLIGHT PANEL AT OPPOSITE IMPACT EDGE, BOTTOM DENTS AT IMPACT SLIGHT BULGE ON TOP SURFACE
21"	X		PRONOUNCED BULGE ON TOP AT IMPACT EDGE PRONOUNCED PANEL ON BOTTOM OPPOSITE IMPACT EDGE SOME REINFORCEMENTS BROKE LOOSE

TRAY PACK TESTS

SAMPLE NUMBER: 27 DATE: 4/10/83

TEST TYPE: TRAY PACK SIDE DROP

SAMPLE CONFIGURATION: HEAVYWEIGHT - 90# - WATER

TEST LEVEL	DAMAGE		COMMENT
	YES	NO	
3"		X	O.K.
6"		X	O.K.
9"	X		TOP LID IMPACT EDGE ONLY
12"	X		TOP LID IMPACT EDGE GETTING WORSE ONLY
15"	X		TOP LID IMPACT EDGE DENT IN IMPACT EDGE
18"	X		TOP LID IMPACT EDGE FAIRLY BAD DENT IN IMPACT EDGE GETTING WORSE
21"	X		TOP LID IMPACT EDGE DISTORTED SO AS TO PREVENT OPENING

TRAY PACK TESTS

SAMPLE NUMBER: 28 DATE: 4/10/83

TEST TYPE: TRAY PACK SIDE DROP

SAMPLE CONFIGURATION: HEAVYWEIGHT - 90# - WATER

TEST LEVEL	DAMAGE		COMMENT
	YES	NO	
3"		X	O.K.
6"		X	O.K.
9"		X	O.K.
12"	X		TOP LID IMPACT EDGE ONE SIDE ONLY SLIGHT DENT IN IMPACT EDGE SAME SIDE
15"	X		TOP LID IMPACT EDGE BOTH SIDES DENT IN IMPACT EDGE SAME SIDE AS 12" BUCKLE GETTING WORSE SLIGHT DENT 15" SIDE
18"	X		TOP LID BUCKLES WORSENING EDGE DENTS PRONOUNCED
21"	X		TOP LID BUCKLES BAD BUT CAN STILL BE OPENED PANEL IN BOTTOM BOTH SIDES OPPOSITE IMPACT EDGE

TRAY PACK TESTS

SAMPLE NUMBER: 29 DATE: 4/10/83

TEST TYPE: TRAY PACK SIDE DROP WATER - 6½#

SAMPLE CONFIGURATION: HEAVYWEIGHT - 90# - WATER

TEST LEVEL	DAMAGE		COMMENT
	YES	NO	
3"		X	O.K.
6"	X		TOP LID ONE SIDE ONLY
9"	X		TOP LID ONE SIDE ONLY
12"	X		TOP LID BOTH SIDES DENT
15"	X		TOP LID BOTH SIDES
18"	X		TOP LID BUCKLED TO THE POINT WHERE IT CAN'T BE OPENED ALSO BOTTOM OPPOSITE IMPACT SIDE PANELED

TRAY PACK TESTS

SAMPLE NUMBER: 30 DATE: 4/10/83

TEST TYPE: TRAY PACK SIDE DROP 7½#

SAMPLE CONFIGURATION: STANDARD CAN OF PEAS

TEST LEVEL	DAMAGE		COMMENT
	YES	NO	
3"		X	O.K.
6"	X		BAD BOTTOM PANEL BOTH SIDES

TRAY PACK TESTS

SAMPLE NUMBER: 31 DATE: 12/16/82

TEST TYPE: SIDE DROP TEST · SHIPPING CONTAINER

SAMPLE CONFIGURATION: SHIPPING CONTAINER, BASELINE

SHIPPING CONTAINER, BASELINE TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
4"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
6"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
8"	TP #4		X	#5 CARDBOARD SPACER
	TP #3			HAS CAN RIM INDENT ON
	TP #2			UNDERSIDE THE OTHERS
	TP #1			DO NOT
10"	TP #4	X		#5 SPACER INDENTS
	TP #3		X	VERY HEAVY - OTHERS
	TP #2		X	STARTING TO SHOW
	TP #1	X		
12"	TP #4	X		
	TP #3		X	#5 SPACER CORNER TOTALLY
	TP #2		X	COLLAPSED AT IMPACT EDGE;
	TP #1	X		#4 TRAY PACK ONLY ONE WITH
				TOP DAMAGE

TRAY PACK TESTS

SAMPLE NUMBER: 32 DATE: 12/16/82

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: FOAM PAD SHIPPING CONTAINER
BASELINE TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
4"	TP #4		X	FOAM PADS CARRY
	TP #3		X	TRAY PACK INDENT
	TP #2		X	PATTERN ON IMPACT
	TP #1		X	EDGE
6"	TP #4		X	EDGE PATTERN GETTING
	TP #3		X	DEEPER - CAN RIM
	TP #2		X	INDENT IN T2 DIMINISHING
	TP #1			THROUGH PAD 2
8"	TP #4		X	SAME AS ABOVE
	TP #3		X	BUT INDENT DEPTHS
	TP #2		X	INCREASING
	TP #1		X	
10"	TP #4		X	IMPACT EDGE PATTERN VERY
	TP #3		X	WELL INDENTED IN FOAM
	TP #2		X	TP #1 VERY SLIGHT PANEL
	TP #1	X		

(CONTINUED)

TRAY PACK TESTS

SAMPLE NUMBER: 32 DATE: 12/16/82

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: FOAM PAD SHIPPING CONTAINER AND BASE-LINE TRAY PACKS REFURBISHED FROM SAMPLE 32 FOR 12" DROP

TEST LEVEL	DAMAGE YES	DAMAGE NO	COMMENT
12" TP #4		X	EDGE INDENTS AS SEVERE AS
TP #3		X	AT END OF TEST (2)
TP #2	X		TP #2 SLIGHT PANEL - 2
TP #1		X	CORNERS
14" TP #4		X	EDGE INDENTS ¼"
TP #3		X	DEEP NOW
TP #2	X		TP #2 PANEL GOT DEEPER
TP #1	X		TP #1 SLIGHT PANEL 1 CORNER

TRAY PACK TESTS

SAMPLE NUMBER: 33 DATE: 12/17/82

SHEET 1

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BUNDLE CONCEPT SHIPPING CONTAINER WITH BASELINE TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
8"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
10"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
12"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
14"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
16"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
18"	TP #4		X	CORNER PIECES 2 U AND 1L
	TP #3		X	FOUND TO BE MISSING ¼"
	TP #2		X	SPACERS. REPLACED FOR
	TP #1		X	NEXT DROP
20"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	#1 BEGINNING TO INDENT
22"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1	X		FAIRLY DEEP

TRAY PACK TESTS

SAMPLE NUMBER: 33 DATE: 12/17/82

SHEET 2

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BUNDLE CONCEPT SHIPPING CONTAINER WITH BASELINE TRAY PACKS

TEST LEVEL	DAMAGE		COMMENT
	YES	NO	
24" TP# 4		X	EXISTING PANEL
TP# 3		X	POPPED OUT; BEGINNING TO
TP# 2		X	INDENT ON IMPACT EDGE
TP# 1	X		

TRAY PACK TESTS

SAMPLE NUMBER: 34 DATE: 12/17/82

SHEET #1

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BASELINE SHIPPING CONTAINER WITH REINFORCED TRAY PACK

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
10"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
12"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
14"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
16"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
18"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
20"	TP #4		X	
	TP #3		X	
	TP #2		X	
	TP #1		X	
22"	TP #4		X	#4 IMPACT EDGE TO SLIGHT BULGE. ALL IMPACT FACES BULGED.
	TP #3			
	TP #2			
	TP #1			
24"	TP #4		X	#4 IMPACT EDGE BULGE INCREASING (WATER ON NON-IMPACT END FACE) AS IS
	TP #3		X	
	TP #2		X	
	TP #1		x	IMPACT FACE BULGE BOX LINER DROP END WELL CREASED

TRAY PACK TESTS

SAMPLE NUMBER: 34 DATE: 12/17/82

SHEET 2

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BASELINE SHIPPING CONTAINER WITH REINFORCED TRAY PACK

TEST LEVEL	DAMAGE YES	DAMAGE NO	COMMENT
26" TP #4		X	# 4 IMPACT EDGE BULGE CONSTANT - WATER ON NON-IMPACT EDGE FACE IMPACT FACE BULGE PROMINENT BUT NO DRAMATIC INCREASE, #1 WATER ON IMDENTS STARTING ON BOTTOM CORNERS NON-IMPACT END
TP #3		X	
TP #2		X	
TP #1		X	
28" TP #4		X	BULGE AT TOP ON IMPACT END GETTING SERIOUS ON #4 ALSO WATER ON NON-IMPACT END, IMPACT END FACE BULGE INCREASED ON ALL, #1 INDENTS GETTING DEEPER BUT STILL MINOR.
TP #3		X	
TP #2		X	
TP #1		X	
30" TP #4		X	#4 MOST INTERIOR TOP RIBS BROKEN AWAY - #3 1 TOP RIB BROKEN AWAY ON NON-IMPACT END. #1 INTERIOR BOTTOM RIBS BROKEN AWAY AT CENTER IMPACT END CORNERS SLIGHTLY PANELED.
TP #3		X	
TP #2		X	
TP #1	X		

TRAY PACK TESTS

SAMPLE NUMBER: 35 DATE: 12/20/82

SHEET #1

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BUNDLE CONCEPT SHIPPING CONTAINER WITH REINFORCED TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
12"	TP# 4		X	
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
14"	TP# 4		X	#4 MANY RIBS BROKEN AWAY ON TOP AT BOTH ENDS. #2 SEVERAL RIBS BROKEN AWAY ON THE BOTTOM - CANS STILL QUITE COLD. REGLUED RIBS AFTER WARMING.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
16"	TP# 4		X	
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
18"	TP# 4		X	IMPACT FACES SHOWING SLIGHT BULGE - 2 RIB ENDS BROKEN AWAY ON #1 AT IMPACT END BOTTOM - REGLUED
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
20"	TP# 4		X	
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
22"	TP# 4		X	
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
24"	TP# 4		X	#4 FACE BULGE MORE PRONOUNCED & BEGINNING BULGE RIGHT CORNER TOP OF IMPACT EDGE. #1 TOP ON IMPACT FACE DENTED IN.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	

TRAY PACK TESTS

SAMPLE NUMBER: 35 DATE: 12/20/82

SHEET #2

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BUNDLE CONCEPT SHIPPING CONTAINER WITH REINFORCED TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
26"	TP# 4 12/21 TP# 3 TRAY PACK TP# 2 WARMED TP# 1 BEFORE TESTING		X X X X	12/21, CARTON PADS ON IMPACT END GETTING COMPRESSED. IMPACT FACE BULGE ON #4 & #1 ENLARGED AS IS DENT ON #1 WHICH IS BEGINNING ON #4.
28"	TP# 4 TP# 3 TP# 2 TP# 1		X X X X	IMPACT EDGE TOP BULGED ON #4 TO DELAMINATE THREE CENTER RIBS - CANNOT RE-GLUE.
30"	TP# 4 TP# 3 TP# 2 TP# 1		X X X X	#4 IMPACT EDGE TOP BULGE GROWING AND SO IS IMPACT FACE BULGE. 4 RIBS NOW DELAMINATED AT IMPACT END. BOTTOM RIBS ON #1 &#2 DE-LAMINATING ON IMPACT END. (2 EACH IN CENTER)
32"	TP# 4 TP# 3 TP# 2 TP# 1		X X X X	IMPACT END TOP EDGE ON #4 SEVERELY DEFORMED. CAN COULD NOT BE OPENED WITH-OUT SOME DIFFICULTY.

TRAY PACK TESTS

SAMPLE NUMBER: 36 DATE: 12/21/82

SHEET #1

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: FOAM PAD SHIPPING CONTAINER WITH REINFORCED TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
14"	TP# 4		X	FOAM PADS INDENTING BUT STILL TIGHT. TOP PAD HAS RIM OUTLINE.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
16"	TP# 4		X	FOAM PAD INNER IMPACT END CRUSHED TO ALLOW ¼" TRAVEL CANS WILL CONTACT END ON NEXT DROP REVERSING PADS.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
18"	TP# 4 PADS		X	FOAM PAD NEW IMPACT END CRUSHED; ABOUT ½" TOTAL TRAVEL NOW.
	TP# 3 ENDS		X	
	TP# 2 REVERSED		X	
	TP# 1		X	
20"	TP# 4		X	PADS CRUSHED BEYOND USE, THEY WILL ALLOW END CONTACT, PADS WILL BE REPLACED #1 HAS 2 RIBS DELAMINATED AT IMPACT END ON BOTTOM CENTER.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
22"	TP# 4 PADS		X	FOAM PADS AT INNER IMPACT END CRUSHED TO ALLOW ¼" TRAVEL - REVERSING PADS.
	TP# 3 REPLACED		X	
	TP# 2		X	
	TP# 1		X	
24"	TP# 4 PADS		X	FOAM PAD IMPACT INNER END CRUSHED TO ALLOW ½" TRAVEL THE ONLY DAMAGE TO TRAY PACKS IS RIB DELAMINATION ON #1, 5 RIBS AT IMPACT END CENTER. NO BULGES OR DENTS.
	TP# 3 REVERSED		X	
	TP# 2		X	
	TP# 1		X	

TRAY PACK TESTS

SAMPLE NUMBER: 36 DATE: 12/21/82

SHEET #2

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: FOAM PAD SHIPPING CONTAINER WITH REINFORCED TRAY PACKS

TEST LEVEL	DAMAGE YES	DAMAGE NO	COMMENT
26" TP# 4 12/22 TP# 3 PADS TP# 2 REPLACED TP# 1		X X X X	FOAM PAD IMPACT (INNER) END CRUSHED TO ALLOW ⅛" TRAVEL. NO DAMAGE TO TRAY PACKS
28" TP# 4 PADS TP# 3 REVERSED TP# 2 TP# 1		X X X X	FOAM PAD IMPACT INNER END CRUSHED TO ALLOW ½" TRAVEL. 5 RIBS ON #1 MORE EXTENSIVELY DELAMINATED. NO DAMAGE TO TRAY PACKS CHANGING PADS

NOTE: THESE CARTONS DO NOT BOUNCE AS THE OTHERS DO.

TRAY PACK TESTS

SAMPLE NUMBER: 37 DATE: 12/22/82

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BASELINE SHIPPING CONTAINER WITH MODIFIED SPACERS AND STRAPS AROUND LINER BASELINE TRAY PACKS

TEST LEVEL	DAMAGE		COMMENT
	YES	NO	
10" TP# 4		X	COULD HEAR "OIL CAN" POP ON DISASSEMBLY OF STRAPPED BUNDLE. #1 SLIGHT PANELS IN CORNERS BOTTOM OPPOSITE IMPACT END. "OIL CANS" WHEN TOP IS PRESSED (OTHERS DON'T)
TP# 3		X	
TP# 2		X	
TP# 1	X		

TRAY PACK TESTS

SAMPLE NUMBER: 38 DATE: 12/23/82

TEST TYPE: SIDE DROP TEST

SAMPLE CONFIGURATION: BASELINE SHIPPING CONTAINER WITH STRAPS AROUND LINER AND 4 SPACERS TOP & BOTTOM ONLY. BASELINE TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
8"	TP# 4		X	
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
10"	TP# 4		X	#1 SLIGHT PANELS IN CORNERS OPPOSITE IMPACT END ON BOTTOM. TOP HAS SAME OIL CANNING AS PREVIOUS TEST. THE OTHERS DON'T.
	TP# 3		X	
	TP# 2		X	
	TP# 1	X		

NOTE: #2 "FEELS" LIKE IT HAS LESS LIQUID IN IT THAN OTHERS. (IE MORE "SLOSH")

TRAY PACK TESTS

SAMPLE NUMBER: 39 DATE: 3/3/83

SHEET #1

TEST TYPE: DROP TEST BUNDLE CONCEPT FOR PROOF OF NEW CORNER BLOCKS

SAMPLE CONFIGURATION: BUNDLE CONCEPT WITH NEW BEADED CORNER BLOCKS AND BASELINE TRAY PACKS

TEST LEVEL	DAMAGE YES	DAMAGE NO	COMMENT
8" TP# 4		X	LOUD SNAPS FROM #3 (2 EACH) WHEN HANDLED. SAME ON #2 OBSERVED DEPRESSION AT CORNER BETWEEN RIBS, SNAP OUT AT IMPACT END.
TP# 3		X	
TP# 2		X	
TP# 1		X	
10" TP# 4		X	IMPACT FACE OF CORNER BLOCKS CRUSHED ABOUT 0.1" SAME DEPRESSIONS SNAPPING ON #3, #2, & #1 AS BEFORE.
TP# 3		X	
TP# 2		X	
TP# 1		X	
12" TP# 4		X	SAME DEPRESSIONS SNAPPING AS BEFORE ON #3, #2 & #1. FURTHER .060 TO .090 COMPRESSION OF IMPACT FACE OF CORNER PADS. PLAY (OIL CAN) MAY BE DEVELOPING IN THE TOPS OF 3 & 2, 1 AT IMPACT END.
TP# 3		X	
TP# 2		X	
TP# 1		X	
14" TP# 4		X	ABOUT .03 MORE COMPRESSION FOAM PAD IMPACT FACES. SAME DEPRESSIONS AND SNAPS AS BEFORE 1, 2, &3. NO CHANGE IN TOPS.
TP# 3		X	
TP# 2		X	
TP# 1		X	
16" TP# 4		X	ADDITIONAL .030 CRUSH ON CORNER PAD IMPACT FACE. SAME SNAP ON SAME TRAY PACK.
TP# 3		X	
TP# 2		X	
TP# 1		X	
18" TP# 4		X	ADDITIONAL .030 TO .060 CRUSH ON IMPACT FACE OF CORNER PADS. SAME SNAP ON SAME TRAY PACKS. NO CHANGE IN TOPS.
TP# 3		X	
TP# 2		X	
TP# 1		X	

TRAY PACK TESTS

SAMPLE NUMBER: 39 DATE: 3/3/83

SHEET #2

TEST TYPE: DROP TEST BUNDLE CONCEPT FOR PROOF OF NEW CORNER BLOCKS

SAMPLE CONFIGURATION: BUNDLE CONCEPT WITH NEW BEADED CORNER BLOCKS AND BASELINE TRAY PACKS

TEST LEVEL		DAMAGE YES	DAMAGE NO	COMMENT
20"	TP# 4		X	ADDITIONAL 0 TO .030 CRUSH ON CORNER PAD IMPACT FACE. SAME SNAP ON SAME TRAY PACKS. NO CHANGE IN TOPS.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
22"	TP# 4	X		AVERAGE IMPACT FACE CORNER PAD THICKNESS ABOUT .85" VS 1.210 WHEN NEW. SLIGHT BULGE BUCKLE IN TOP AT IMPACT END LEFT. FACING SIDE ON #4. SAME SNAPS ON SAME TRAY PACKS.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
24"	TP# 4	X		ADDITIONAL CRUSH ON IMPACT FACE OF CORNER BLOCK NEGLIGABLE, CORNER PANELS BEGINNING OPPOSITE IMPACT END ON #1. SAME SNAPS ON SAME TRAY PACKS. BULGE ON TOP #4 UNCHANGED.
	TP# 3		X	
	TP# 2		X	
	TP# 1		X	
26"	TP# 4	X		ADDITIONAL CRUSH ON IMPACT FACE OF CORNER BLOCKS IS ABOUT .030 AVERAGE. RIGHT FACING TOP CORNER ON #4 HAS NOW BULGE BUCKLED NO INCREASE IN EXISTING. PANEL BEGINNING AT CORNER OPPOSITE IMPACT END ON BOTTOM OF #4, BOTH CORNERS ON #1 PANELED IN OPPOSITE IMPACT END ON BOTTOM. IMPACT END ON #1 BULGED OUT OF SHAPE. SAME SNAPS ON SAME TRAY PACKS.
	TP# 3		X	
	TP# 2		X	
	TP# 1	X		

APPENDIX D

TRAY PACK ACCEPTANCE TEST DATA

1. SHIPPING CONTAINER DROP AND IMPACT TEST DATA

SAMPLE NUMBER	TEST TYPE	SAMPLE TYPE		
		CARTON	TRAY PACK	FOOD
15-BC-B-P	DROP	BASELINE	BASELINE	PEAS
16-BC-B-W	DROP	BASELINE	BASELINE	WATER
11-BC-B-L	DROP	BASELINE	BASELINE	LASAGNA
14-BU-B-P	DROP	BUNDLE	BASELINE	PEAS
15-BU-B-W	DROP	BUNDLE	BASELINE	WATER
11-BU-B-L	DROP	BUNDLE	BASELINE	LASAGNA
110-BC-B-P	IMPACT	BASELINE	BASELINE	PEAS
17-BC-B-W	IMPACT	BASELINE	BASELINE	WATER
13-BC-B-L	IMPACT	BASELINE	BASELINE	LASAGNA
12-BU-B-P	IMPACT	BUNDLE	BASELINE	PEAS
35-BU-B-W	IMPACT	BUNDLE	BASELINE	WATER
18-BU-B-L	IMPACT	BUNDLE	BASELINE	LASAGNA
35-BC-H-P	DROP	BASELINE	HEAVYWEIGHT	PEAS
36-BC-H-W	DROP	BASELINE	HEAVYWEIGHT	WATER
39-BC-H-L	DROP	BASELINE	HEAVYWEIGHT	LASAGNA
34-BU-H-P	DROP	BUNDLE	HEAVYWEIGHT	PEAS
BU-H-W	DROP	BUNDLE	HEAVYWEIGHT	WATER
31-BU-H-L	DROP	BUNDLE	HEAVYWEIGHT	LASAGNA
310-BC-H-P	IMPACT	BASELINE	HEAVYWEIGHT	PEAS
37-BC-H-W	IMPACT	BASELINE	HEAVYWEIGHT	WATER
33-BC-H-L	IMPACT	BASELINE	HEAVYWEIGHT	LASAGNA
39-BU-H-P	IMPACT	BUNDLE	HEAVYWEIGHT	PEAS

APPENDIX D

TRAY PACK ACCEPTANCE TEST DATA

(CONTINUED)

SAMPLE NUMBER	TEST TYPE	SAMPLE TYPE		
		CARTON	TRAY PACK	FOOD
B-H-W	IMPACT	BUNDLE	HEAVYWEIGHT	WATER
36-BU-H-L	IMPACT	BUNDLE	HEAVYWEIGHT	LASAGNA
21-BC-R-P	DROP	BASELINE	REINFORCED	PEAS
26-BC-R-W	DROP	BASELINE	REINFORCED	WATER
25-BC-R-L	DROP	BASELINE	REINFORCED	LASAGNA
21-BU-R-P	DROP	BUNDLE	REINFORCED	PEAS
BU-R-W	DROP	BUNDLE	REINFORCED	WATER
24-BU-R-L	DROP	BUNDLE	REINFORCED	LASAGNA
23-BC-R-P	IMPACT	BASELINE	REINFORCED	PEAS
27-BC-R-W	IMPACT	BASELINE	REINFORCED	WATER
210-BL-R-L	IMPACT	BASELINE	REINFORCED	LASAGNA
25-BU-R-P	IMPACT	BUNDLE	REINFORCED	PEAS
BU-R-W	IMPACT	BUNDLE	REINFORCED	WATER
22-BU-R-L	IMPACT	BUNDLE	REINFORCED	LASAGNA
BC-R-H-P	DROP	BASELINE	HEAVYWEIGHT REINFORCED	PEAS
31-BC-HR-W	DROP	BASELINE	HEAVYWEIGHT REINFORCED	WATER
BC-RH-L	DROP	BASELINE	HEAVYWEIGHT REINFORCED	LASAGNA
BU-RH-P	DROP	BUNDLE	HEAVYWEIGHT REINFORCED	PEAS
BU-HR-W	DROP	BUNDLE	HEAVYWEIGHT REINFORCED	WATER
BU-RH-L	DROP	BUNDLE	HEAVYWEIGHT REINFORCED	LASAGNA

APPENDIX D

TRAY PACK ACCEPTANCE TEST DATA

(CONTINUED)

SAMPLE NUMBER	TEST TYPE	SAMPLE TYPE		
		CARTON	TRAY PACK	FOOD
BC-RH-P	IMPACT	BASELINE	HEAVYWEIGHT REINFORCED	PEAS
31-BC-HR-W	IMPACT	BASELINE	HEAVYWEIGHT REINFORCED	WATER
BC-RH-L	IMPACT	BASELINE	HEAVYWEIGHT REINFORCED	LASAGNA
BU-RH-P	IMPACT	BUNDLE	HEAVYWEIGHT REINFORCED	PEAS
BU-HR-W	IMPACT	BUNDLE	HEAVYWEIGHT REINFORCED	WATER
BU-RH-L	IMPACT	BUNDLE	HEAVYWEIGHT REINFORCED	LASAGNA

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE TRAY PACKS FILLED WITH PEAS

DATE: 4/12/83

TEST CARTON CODE: 15-BC-B-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	Top tape @ side 3 burst - Retaped
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner ~ 3/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner ~ 3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner ~ ¼"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner ~ 3/8"

INSPECTION:

CARTON: All four corners crushed in.

LINER: Slight crushing at all four bottom corners.

PADS: #1 corners slightly crushed, 2-5 show indent of traypack tops.

TRAYPACK	INSPECTION COMMENTS
#4	Top buckled bottom paneled on #1 side end, bottom only paneled on #3 side end.
#3	Bottom paneled all four corners, top O.K.
#2	1-2, 1-4, and 2-3 corners paneled, top O.K.
#1	Bottom panels slight in all four corners, top O.K. sides paneled from drop @ 26" probable.

Tray Pack #4 shows the most severe damage. The magnitude of the damage lessens as the position of the Tray Pack proceeds to #1 which is least severe. Tray Packs 1, 2 & 4 sides showed long panels out as if from a crushing load. It is presumed that this occurred during the 26" bottom drop. There was no apparent leakage from any of the containers (Tray Packs). None were so badly deformed as to preclude fitting the steam table. (ie the side panel deformation was slight)

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE TRAY PACKS FILLED WITH WATER DATE: 4/13/83

TEST CARTON CODE: 16-BC-B-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner ~ 3/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner ~ 3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner ~ 3/8"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner ~ 3/8"

INSPECTION:

CARTON: All four corners crushed in ~ 3/8".

LINER: All four bottom corners slightly crushed.

PADS: Slight indent of traypack bottom on #1 to 4.
#1 has all four corners slightly crushed.

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	No Damage

Only about ¼" of space at carton top.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE TRAY PACKS FILLED WITH LASAGNA

DATE: 4/12/83

TEST CARTON CODE: 11-BC-B-L

DROP	26"	DONE	COMMENT
CARTON BOTTOM	13"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed side 2-3 corner ~3/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed side 1-4 corner ~ 3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed side 1-2 corner ~ 3/8"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed side 3-4 corner ~ 3/8"

INSPECTION:

CARTON: All four bottom corners crushed in ~ 3/8".

LINER: All four bottom corners slightly crushed.

PADS: Pads show Tray Pack bottom indentation.
#1 has all four corners slightly crushed.

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	No Damage

~ ½" of space now exists at the top of the carton. This is most likely due to accummulated "crush" in the pads. The peas did not show this accumulation.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CARTON WITH BASELINE TRAY PACKS FILLED WITH PEAS

DATE: 4/15/83

TEST CARTON CODE: 14-BU-B-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed bottom side 2-3 corner ~ 1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed bottom side 1-4 corner ~ 1"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed bottom side 1-2 corner ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed bottom side 3-4 corner ~ 1"

INSPECTION:

CARTON: All four bottom corners crushed in ~ 1".

LINER: No Damage

PADS: No damage to fiberboard pads, bottom pad on bottom corner pads compressed ~ .3", all others no damage.

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	All four top corners pulled in and Tray Pack bottom bowed out. (Bottom, .25" - top, .067")

No leakage was observed on TP#1 and the deformations while interesting would not preclude the use of the Tray pack either in serving or opening.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH BASELINE TRAY PACKS FILLED WITH WATER DATE: 4/23/83

TEST CARTON CODE: 15-BU-B-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	2-3 corner pushed in ~ 1"
BOTTOM SIDE 1-4 CORNER	13"	X	1-4 corner pushed in ~ 5/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	1-2 corner pushed in ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	3-4 corner pushed in ~ 1"

INSPECTION:

CARTON: All four corners crushed in ~ 1" except 1-4 which is only 5/8"

LINER: No Damage

PADS: Bottom corner pad bottoms crushed ~ .15", top of tops only about .040".

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	Top corners pushed in slightly (.060 max. .028 min.)

Carton accidently dropped on top 2-3 corner in testing; Tray Packs O.K.- no leaks all use worthy.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON DATE: 4/23/83
WITH BASELINE TRAY PACKS FILLED WITH LASAGNA

TEST CARTON CODE: 11-BU-B-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	2-3 corner crushed in ~1"
BOTTOM SIDE 1-4 CORNER	13"	X	1-4 corner crushed in ~3/4"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	1-2 corner crushed in ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	3-4 corner crushed in ~ 1"

INSPECTION:

CARTON:

LINER:

PADS:

TRAYPACK	INSPECTION COMMENTS
#4	Slight beginnings of panels at all four corners on bottom.
#3	No Damage
#2	No Damage
#1	All four top corners pushed in ~ .060". Slight bulges at inside of 3 corners (popped back in)

Tray Pack damage is minimal with out leakage. Tray Pack still use-worthy.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE TRAY PACKS FILLED WITH PEAS DATE: 5/14/83

TEST CARTON CODE: 110-BC-B-P

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON CARTON FACE AT IMPACT END FROM SLINGS.
LINER	
PADS	

TP #4	TOP CORNERS BUCKLED AT IMPACT END ~ .095" BOTTOM CORNERS BADLY PANELED AT END OPPOSITE IMPACT; SHARP CREASES IN METAL. POSSIBLE RUPTURE OF CAN LINER AND POSSIBLE FATIGUE CRACKING OF METAL AT CREASES. PANEL = ~ .235" DEEP.
TP#3	SAME AS #4 PANEL UP TO .265" DEEP) WHOLE TOP AT IMPACT END LOOKS BUCKLED .1"
TP #2	SAME AS #3 PANEL UP TO .173" DEEP)
TP #1	SAME AS #2 PANEL UP TO .375" DEEP)

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE TRAY PACKS FILLED WITH WATER

DATE: 5/14/83

TEST CARTON CODE: 17-BC-B-W

DAMAGE DESCRIPTION	
CARTON	SLIGHT IMDENTS ON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS ON IMPACT FACE FROM TRAY PACK ENDS.
PADS	SLIGHT INDENTS FROM TRAY PACK TOPS AND BOTTOMS

TP #4	TOP CORNERS BUCKLED ~ .1" ON IMPACT END. NO LEAKAGE OBSERVED, CAN COULD STILL BE OPENED.
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE TRAY PACK FILLED WITH LASAGNA

DATE: 5/14/83

TEST CARTON CODE: 13-BC-B-L

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS ON IMPACT FACE FROM TRAY PACK ENDS.
PADS	SLIGHT INDENTS FROM TRAY PACK TOPS AND BOTTOMS.

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH BASELINE TRAY PACKS FILLED WITH PEAS DATE: 5/14/83

TEST CARTON CODE: 12-BU-B-P

DAMAGE DESCRIPTION	
CARTON	VERY SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	
PADS	IMPACT FACE OF IMPACT END CORNER PADS CRUSHED .120"

TP #4	BOTH CORNERS PANELED ON BOTTOM ON NON-IMPACT END. PANEL IS ABOUT .075" DEEP. NOT BAD ENOUGH TO DAMAGE INSIDE LINER OR BREAK METAL.
TP#3	SAME AS #4 BUT ONLY ONE CORNER PANELED. (.08" ~ DEEP)
TP #2	SAME AS #4 BUT ONLY ONE CORNER PANELED ~.08" DEEP. THE OTHER JUST SHOWS A PANEL BEGINNING.
TP #1	NO DAMAGE BUT ONE CORNER OPPOSITE IMPACT END SHOWS A PANEL JUST BEGINNING.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH BASELINE TRAY PACKS FILLED WITH WATER DATE: 5/14/83

TEST CARTON CODE: 35-BU-B-W

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	NO DAMAGE
PADS	IMPACT FACE OF IMPACT END CORNER PADS COMPRESSED ABOUT .115".

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY P. CK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH BASELINE TRAY PACKS FILLED WITH LASAGNA DATE: 5/14/83

TEST CARTON CODE: 18-BU-B-L

DAMAGE DESCRIPTION	
CARTON	CARTON SKIN BROKEN ON IMPACT FACE BY SLING KNOT AT IMPACT.
LINER	
PADS	IMPACT FACE OF CORNER PAD AT IMPACT END CRUSHED .130".

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVY WEIGHT TRAY PACKS FILLED WITH PEAS

DATE: 4/30/83

TEST CARTON CODE: 35-BC-H-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner ~ ½"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner ~ ½"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner ~3/8"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner ~ ½"

INSPECTION:

CARTON: All four bottom corners crushed in ~ 3/8" - ½"

LINER: All four bottom corners slightly crushed.

PADS: #1 has all four bottom corners slightly crushed, others have no damage but show Tray Pack indents.

TRAY PACK	INSPECTION COMMENTS
#4	Incipient panels in bottom edge @ all four corners.
#3	Incipient paneling at 1-2, and 2-3 corners.
#2	Slight panels at 2-3 corner.
#1	Incipient paneling at 1-2 corner.

The Tray Packs had no damage that caused leakage or made them unusable.
Incipient panels were visually detectable and about .015" deep.
Slight panels were more severe but only about .060" deep.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVY WEIGHT TRAY PACKS FILLED WITH WATER DATE: 4/14/83

TEST CARTON CODE: 36-BC-H-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed side 2-3 bottom corner ~ 3/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed side 1-4 bottom corner ~ 3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed side 1-2 bottom corner ~ ¼"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed side 3-4 bottom corner ~ 3/8"

INSPECTION:

CARTON: All four corners crushed ¼" to 3/8" on bottom.

LINER: All four corners crushed slightly.

PADS: Pad 1-4 carry slight indents of Tray Pack bottom. corners, #1 has all four bottom corners slightly crushed.

TRAY PACK	INSPECTION COMMENTS
#4	Slight bulges in top corners 3 places. Most severe is .020"
#3	No Damage
#2	No Damage
#1	No Damage

The damage to the #4 Tray Pack lid is not severe enough to cause any difficulty in opening the Tray Pack.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVY WEIGHT TRAY PACKS FILLED WITH LASAGNA DATE: 5/7/83

TEST CARTON CODE: 39-BC-H-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Corner pushed in ~ ½"
BOTTOM SIDE 1-4 CORNER	13"	X	Corner pushed in ~ ½"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed in corner ~ ½"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed in corner ~ ½"

INSPECTION:

CARTON: All four corners crushed in ½" (bottom).

LINER: All four bottom corners crushed in slightly.

PADS: All have indent of Tray Pack top and bottoms.
#1 has all four corners slightly crushed.

TRAY PACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	No Damage

All Tray Packs in serviceable condition.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON DATE: 4/30/83
FILLED WITH HEAVY WEIGHT TRAY PACKS FILLED WITH PEAS

TEST CARTON CODE: 34-BU-H-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	Bulge in side 3 about 2" up
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner in ~ 1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner in ~3/4"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	Bulge in side 1 about 2" up
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner in ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner in ~ 1"

INSPECTION:

CARTON: All four corners crushed in ~ 1". Sides show creases ~ 2" up from bottom (top corner pushed in)

LINER: No Damage

PADS: Bottom of bottom foam corner pads crushed ~ .3". Fiberboard pads just show rim and bottom indents.

TRAY PACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	Top pushed in at corners, bottom corners show indents at ends of grooves.

Carton dropped on top 2-3 corner in error. Top corners have been depressed ~ .-6" with some wrinkling of the metal at the corners. No leakage is evident through the top "oil cans" as the contents shifts. I believe the Tray Pack (#1) is still serviceable.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH HEAVY WEIGHT TRAY PACKS FILLED WITH WATER DATE: 5/20/83

TEST CARTON CODE: BU-H-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	Slight bulge bottom 1/3" side 3
BOTTOM SIDE 2 EDGE	13"	X	Slight bulge bottom 1/3" side 2
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed bottom 2-3 corner ~ 1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed bottom 1-4 corner ~3/4"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	Slight bulge bottom 1/3" side 1
BOTTOM SIDE 4 EDGE	13"	X	Buckle @ bottom 1/3" side 4
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed bottom 1-2 corner ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed bottom 3-4 corner ~1"

INSPECTION:

CARTON: All four sides buckle creased ~ 1/3 up from bottom.

LINER: No Damage

PADS: Top surface of top pads crushed ~ 1". Bottom surface bottom pads crushed ~ .25".

TRAY PACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	Top corners pushed in ~ .030" Bottom buckled out ~ .035".

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH HEAVY WEIGHT LASAGNA TRAY PACKS DATE: 5/7/83

TEST CARTON CODE: 31-BU-H-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	Bulge in side 3 ~ 2" up from bottom
BOTTOM SIDE 2 EDGE	13"	X	Bulge in side 2 ~ 2" up from bottom
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed corner ~ 1" in
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed corner ~ 3/4" in
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	Bulge in side 1 ~ 2" up
BOTTOM SIDE 4 EDGE	13"	X	Bulge in side 4 ~ 2" up
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed corner ~ 1" in
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed corner ~ 1" in

INSPECTION:

CARTON: All four corners pushed in ~ 1". All four sides buckled ~ 2" up from bottom.

LINER: No Damage

PADS: No Damage except bottom of bottom corner pads crushed ~ .3"

TRAY PACK	INSPECTION COMMENTS
#4	No Damage
#3	Slight panel @ 2-3 corner
#2	Top corners pushed in slightly
#1	Top corners pushed in more severely

(See Supplementary Comments)

SUPPLEMENTARY COMMENTS

Side buckles on carton preclude any load carrying ability (for the carton). No Tray Packs had damage severe enough to be unserviceable. Bottom corner panel on #3 is almost undetectable (less than 0.020 deep). The corner depressions are about 0.1" deep with some wrinkling of the metal at the corners. Still they are not severe enough to stop an opener.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT TRAY PACKS FILLED WITH PEAS DATE: 5/14/83

TEST CARTON CODE: 310-BC-H-P

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS AT IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS AT IMPACT FACE FROM TRAY PACK ENDS.
PADS	SLIGHT INDENTS FROM TRAY PACK TOPS AND BOTTOMS.

TP #4	TOP CORNERS BUCKLED - .035" ON IMPACT FACE: BOTTOM CORNERS PANELED IN BADLY WITH SHARP CREASES IN METAL. POSSIBLE RUPTURE OF CAN LINER AND POSSIBLE FATIGUE CRACKING OF METAL AT CREASE. PANEL = .22" DEEP AT END OPPOSITE IMPACT.
TP#3	SAME AS #4
TP #2	NO BUCKLE IN TOP CORNERS BUT SAME BAD CREASES IN BOTTOM CORNERS OPPOSITE IMPACT END. PANELS = .200" DEEP AT WORST SITE.
TP #1	SAME AS #2 PANELS - .220" DEEP.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT TRAY PACKS FILLED WITH WATER

DATE: 5/14/83

TEST CARTON CODE: 37-BC-H-W

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS ON IMPACT END FROM TRAY PACK ENDS.
PADS	SLIGHT INDENTS FROM TRAY PACK TOPS AND BOTTOMS.

TP #4	IMPACT END CORNER TOPS BULGED OUT - .030" NOT SUFFICIENT TO PREVENT OPENING. NO LEAKAGE OBSERVED.
TP#3	NO DAMAGE.
TP #2	NO DAMAGE.
TP #1	NO DAMAGE.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT TRAY PACKS FILLED WITH LASAGNA DATE: 5/14/83

TEST CARTON CODE: 33-BC-H-L

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS FROM TRAY PACK ENDS ON IMPACT FACE.
PADS	SLIGHT INDENTS FROM TRAY PACK TOP AND BOTTOMS.

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH HEAVYWEIGHT PEAS DATE: 5/21/83

TEST CARTON CODE: 39-BU-H-P

DAMAGE DESCRIPTION	
CARTON	CARTON CRUSHING IN SLINGS, NOT VERY STIFF.
LINER	NO DAMAGE
PADS	CRUSHED AS USUAL

TP #4	SLIGHT CORNER PANELS AT BOTH CORNERS. NON-IMPACT END TRAY PACK STILL GOOD.
TP#3	NO DAMAGE
TP #2	SLIGHT CORNER PANEL AT ONE CORNER. NON-IMPACT END TRAY PACK STILL GOOD.
TP #1	MODERATE CORNER PANEL ONE CORNER. NON-IMPACT END TRAY PACK STILL GOOD.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH HEAVYWEIGHT TRAY PACKS FILLED WITH WATER DATE: 5/21/83

TEST CARTON CODE: BU-H-W

DAMAGE DESCRIPTION	
CARTON	NO DAMAGE BUT SLIGHT INDENTS IN CARTON IMPACT FACE FROM SLINGS.
LINER	NO DAMAGE
PADS	CORNER PADS ON IMPACT FACE CRUSHED .15" - 2", REARS CRUSHED .05" - .06".

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH HEAVYWEIGHT LASAGNA DATE: 5/21/83

TEST CARTON CODE: 36-BU-H L

DAMAGE DESCRIPTION	
CARTON	NO DAMAGE
LINER	NO DAMAGE
PADS	CRUSHED AS USUAL

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED TRAY PACKS FILLED WITH PEAS DATE: 4/13/83

TEST CARTON CODE: 21-BC-R-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Side 2-3 corner crushed ~ 3/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Side 1-4 corner crushed ~ 3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Side 1-2 corner crushed ~ 3/8"
BOTTOM SIDE 3-4 CORNER	13"	X	Side 3-4 corner crushed ~ 3/8"

INSPECTION:

CARTON: All four corners on bottom crushed in ~ 3/8"

LINER: All four corners on bottom slightly crushed.

PADS: Slight indent of Tray Packs bottom on #1 to #4 #1 corners slightly crushed.

TRAYPACK	INSPECTION COMMENTS
#4	Sides look buckled in slightly all around.
#3	Sides look buckled in slightly all around.
#2	Side buckles less noticeable than 4 and 3.
#1	Side buckles less noticeable than 4 and 3 except on end 3 where center buckled out.

(See Supplementary Comments)

SUPPLEMENTARY COMMENTS

Tray Packs settled about 3/8" below liner level. The side buckles pointed in rather than out in this case (except #1 end 3). None were so bad as to preclude fitting the steam table. The depth was $\sim$ 0.040" in the worst case (#4) and lessened in severity as the Tray Pack position proceeded to #1. Tray Pack #1 end 3 buckle out also protruded about 0.040". This is less than the reinforceing boss on the Tray Pack end and therefore is not considered critical.

There is no apparent leakage from any containers.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON FILLED WITH REINFORCED TRAY PACKS WITH WATER DATE: 4/23/83

TEST CARTON CODE: 26-BC-R-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed in 2-3 corner ~ ¼"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed in 1-4 corner ~ ¼"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed in 2-1 corner ~ ¼"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed in 3-4 corner ~ ¼"

INSPECTION:

CARTON: All four bottom corners crushed in ~ ¼".

LINER: All four bottom corners slightly crushed.

PADS: Slight indents for Tray Packs tops and bottoms. #1 has all four corners slightly crushed.

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	No Damage

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON REINFORCED TRAY PACKS FILLED WITH LASAGNA

DATE: 4/13/83

TEST CARTON CODE: 25-BC-R-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Side 2-3 corner crushed ~ 3/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Side 1-4 corner crushed ~ 3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Side 1-2 corner crushed ~ 3/8"
BOTTOM SIDE 3-4 CORNER	13"	X	Side 3-4 corner crushed ~ 3/8"

INSPECTION:

CARTON: All four corners crushed in ~ 3/8" (on bottom).

LINER: All four bottom corners slightly crushed.

PADS: #1-4 have Tray Pack bottom indents (slight).
#1 has all four corners slightly crushed.

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	Slight panel in at side 2 ~ .042" deep.
#2	No Damage
#1	No Damage

There was no apparent leakage from any Tray Pack. The damage to #3 on side 2 was slight (.040" deep panel in) and not sufficient to preclude fitting the steam table.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH REINFORCED TRAY PACKS FILLED WITH PEAS DATE: 4/30/83

TEST CARTON CODE: 21-BU-R-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed bottom 2-3 corner in ~1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed bottom 1-4 corner in ~1"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner in ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner in ~ 1"

INSPECTION:

CARTON: All four corners crushed about 1"

LINER: No Damage

PADS: Corner pad bottom on bottom crushed about .170"

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	No Damage

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON DATE: 5/20/83
WITH REINFORCED BASELINE TRAY PACKS FILLED WITH WATER

TEST CARTON CODE: BU-R-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	Slight bulge in bottom ¼" side 3
BOTTOM SIDE 2 EDGE	13"	X	Slight bulge in bottom 1/3" side 2
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed bottom 2-3 corner ~1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed bottom 1-4 corner ~3/4"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	Slight bulge in bottom 1/3" side 1
BOTTOM SIDE 4 EDGE	13"	X	Slight bulge in bottom 1/3" side 4
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed bottom 2-1 corner ~1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed bottom 3-4 corner ~1"

INSPECTION:

CARTON: Bottom corners crushed in ~ 1". All four sides have internal buckle creases.

LINER: No Damage

PADS: Impact (top) face of top pads crushed ~.1"
Bottom pads bottom face crushed ~.2".

TRAYPACK	INSPECTION COMMENTS
#4	No Damage
#3	No Damage
#2	No Damage
#1	No Damage

Although the carton sides are buckled the corners are still stiff and able to carry some crush load.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH REINFORCED TRAY PACKS FILLED WITH LASAGNA DATE: 4/30/83

TEST CARTON CODE: 24-BU-R-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner in ~ 3/4"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner in ~3/4"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 2-1 corner in ~3/4"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner in ~3/4"

INSPECTION:

CARTON: All four corners on bottom crushed in. Carton inside shows all four sides buckled about 2½"-3" up from bottom.

LINER: No Damage

PADS: No damage to fiberboard pads. Bottom of bottom foam pads crushed ~ .170".

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED BASELINE TRAY PACKS FILLED WITH PEAS DATE: 5/14/83

TEST CARTON CODE: 23-BC-R-P

	DAMAGE DESCRIPTION
CARTON	SLIGHT INDENTS FROM SLINGS ON IMPACT ENDS.
LINER	SLIGHT INDENTS FROM TRAY PACK ENDS.
PADS	NO DAMAGE

TP #4	VERY SLIGHT INCIPIENT PANEL AT ONE CORNER ON BOTTOM OPPOSITE IMPACT END. TOO SLIGHT TO MEASURE.
TP#3	NO DAMAGE
TP #2	SAME AS #4
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED TRAY PACK FILLED WITH WATER DATE: 5/14/83

TEST CARTON CODE: 27-BC-R-W

	DAMAGE DESCRIPTION
CARTON	SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS ON IMPACT FACE FROM TRAY PACK ENDS.
PADS	NO DAMAGE

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH BASELINE REINFORCED TRAY PACKS FILLED WITH LASAGNA DATE: 5/14/83

TEST CARTON CODE: 210-BC-R-L

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON CARTON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS FROM TRAY PACK ENDS ON IMPACT FACE.
PADS	NO DAMAGE

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH REINFORCED TRAY PACKS FILLED WITH PEAS DATE: 5/14/83

TEST CARTON CODE: 25-BU-R-P

DAMAGE DESCRIPTION	
CARTON	SLIGHT INDENTS ON IMPACT FACE FROM SLINGS.
LINER	SLIGHT INDENTS AT IMPACT END FROM TRAY PACK ENDS.
PADS	IMPACT END IMPACT FACE CORNER PADS CRUSHED - .150". OPPOSITE END (NON-IMPACT END AND FACE) CRUSHED - .100.

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON DATE: 5/21/83
WITH REINFORCED WATER

TEST CARTON CODE: BU-R-W

	DAMAGE DESCRIPTION
CARTON	SLIGHT BUCKLE ON NON-IMPACT END SIDES.
LINER	NO DAMAGE
PADS	CRUSHED AS USUAL.

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH REINFORCED TRAY PACK FILLED WITH LASAGNA DATE: 5/14/83

TEST CARTON CODE: 22-BU-R-L

DAMAGE DESCRIPTION	
CARTON	NON-IMPACT END PUSHED IN - 1/8".
LINER	NO DAMAGE BUT VERY SLIGHT INDENTS AT IMPACT FACE FROM TP ENDS.
PADS	IMPACT FACE OF CORNER PADS AT IMPACT END CRUSHED - .1"+.

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT REINFORCED PEAS DATE: 6/2/83

TEST CARTON CODE: BC-R-H-P

DAMAGE DESCRIPTION	
CARTON	NO DAMAGE
LINER	NO DAMAGE BUT IMPRINTS OF TRAY PACK ENDS AT IMPACT END.
PADS	NO DAMAGE

TP #4	VERY SLIGHT (- .020") BULGE BUCKLE AT 1 CORNER OF IMPACT END.
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT REINFORCED WATER

DATE: 6/2/83

TEST CARTON CODE: 31-BC-H-R-W

DAMAGE DESCRIPTION	
CARTON	INDENTS ON IMPACT FACE FROM DROP SLINGS.
LINER	NO DAMAGE, INDENTS FROM TRAY PACK ENDS ON IMPACT FACE INSIDE.
PADS	NO DAMAGE

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED HEAVYWEIGHT TRAY PACKS WITH LASAGNA

DATE: 6/1/83

TEST CARTON CODE: BC-RH-L

DAMAGE DESCRIPTION	
CARTON	IMPACT FACE HAS INDENTS FROM DROP SLINGS.
LINER	IMPACT FACE INSIDE BEARS INDENTS FROM TRAY PACK ENDS.
PADS	NO DAMAGE

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED HEAVY WEIGHT PEAS DATE: 6/2/83

TEST CARTON CODE: BC-R-H-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner in ~ ½"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner in ~3/8"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner ~ ½" in
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner ~ ½" in

INSPECTION:

CARTON: All four bottom corners crushed in ~ ½".

LINER: All four bottom corners slightly crushed in.

PADS: All but #5 (top pad) bear imprint of Tray Pack bottom(s) ~ .060" deep at worst case.

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVY WEIGHT REINFORCED TRAY PACKS FILLED WITH WATER DATE: 4/14/83

TEST CARTON CODE: 31-BC-H-R-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed bottom 2-3 corner ~¼"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed bottom 1-4 corner ~¼"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed bottom 1-2 croner ~¼"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed bottom 3-4 corner ~¼"

INSPECTION:

CARTON: All four bottom corners crushed in ~ ¼".

LINER: All four bottom corners slightly crushed.

PADS: Slight indent from Tray Pack bottom #1 to #4. #1 has four corners slightly crushed.

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED HEAVY WEIGHT LASAGNA DATE: 5/31/83

TEST CARTON CODE: BC-R-H-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	
BOTTOM SIDE 2 EDGE	13"	X	
BOTTOM SIDE 2-3 CORNER	13"	X	Corner crushed in ~ 5/8"
BOTTOM SIDE 1-4 CORNER	13"	X	Corner crushed in ~ ½"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	
BOTTOM SIDE 4 EDGE	13"	X	
BOTTOM SIDE 1-2 CORNER	13"	X	Corner crushed in ~ ½"
BOTTOM SIDE 3-4 CORNER	13"	X	Corner crushed in ~ ½"

INSPECTION:

CARTON: All four bottom corners crushed in ~ ½" - 5/8"

LINER: All four bottom corners slightly crushed.

PADS: All bear ~ 1/16" deep imprints of Tray Pack bottoms, #1 has all four corners slightly crushed in.

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CARTON WITH REINFORCED HEAVY WEIGHT PEAS

DATE: 6/2/83

TEST CARTON CODE: BU-R-H-P

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	Buckled side 3 ~ 2" from bottom
BOTTOM SIDE 2 EDGE	13"	X	Buckled side 2 ~ 2" from bottom
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner in ~ 1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner in ~ 3/4"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	Buckled side 1 ~ 2" up from bottom
BOTTOM SIDE 4 EDGE	13"	X	Buckled side 4 ~ 2" up from bottom
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner in ~ 1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner in ~ 1"

INSPECTION:

CARTON: All four bottom corners crushed in ~ 1" and all four sides buckled ~ 2" up from the bottom.

LINER: No Damage.

PADS: Top of top pads crushed ~ .12", bottom of bottom pads crushed ~ .20". No damage but Tray Pack bottom indents on fiberboard pads.

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

THE BUNDLE IS A LOOSE FIT IN CARTON AFTER TEST.

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CARTON WITH HEAVY WEIGHT REINFORCED WATER DATE: 6/2/83

TEST CARTON CODE: BU-H-R-W

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	
BOTTOM SIDE 3 EDGE	13"	X	Side 3 buckled about 2" up from bottom
BOTTOM SIDE 2 EDGE	13"	X	Side 2 buckled about 2" up from bottom
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner in ~1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner in ~1"
CARTON TOP	13"	X	
BOTTOM SIDE 1 EDGE	13"	X	Side 1 buckled about 2" up from bottom
BOTTOM SIDE 4 EDGE	13"	X	Side 4 buckled about 2" up from bottom
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner in ~1"
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner in ~1"

INSPECTION:

CARTON: All four bottom corners crushed in and all four sides buckled about 2" from bottom.

LINER: NO DAMAGE

PADS: Top of top pads crushed ~.10", bottom of bottom pads crushed ~.20". No damage to fiberboard pads.

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

DROP TEST DATA SHEET

TEST CARTON DESCRIPTION: BUNDLE CARTON WITH REINFORCED HEAVY WEIGHT LASAGNA DATE: 6/1/83

TEST CARTON CODE: BU-R-H-L

DROP		DONE	COMMENT
CARTON BOTTOM	26"	X	Bottom of bottom pads crushed ~ .14"
BOTTOM SIDE 3 EDGE	13"	X	#3 Carton face buckled ~ 2" up from bottom
BOTTOM SIDE 2 EDGE	13"	X	#2 Carton face buckled ~ 2" up from bottom
BOTTOM SIDE 2-3 CORNER	13"	X	Crushed 2-3 corner in ~ 1"
BOTTOM SIDE 1-4 CORNER	13"	X	Crushed 1-4 corner in ~ 1"
CARTON TOP	13"	X	No Damage
BOTTOM SIDE 1 EDGE	13"	X	Bottom of #1 face buckled ~ 2" up
BOTTOM SIDE 4 EDGE	13"	X	Bottom of #4 face buckled ~ 2" up
BOTTOM SIDE 1-2 CORNER	13"	X	Crushed 1-2 corner ~ 3/4" in
BOTTOM SIDE 3-4 CORNER	13"	X	Crushed 3-4 corner ~ 3/4" in

INSPECTION:

CARTON: All four bottom corners crushed in ~ 3/4" - 1"

LINER: No Damage

PADS: Top of top pads crushed in ~ 14", bottom of bottom pads crushed .23". Fiberboard pad #4 has imprint of T.P. bottom.

TRAYPACK	INSPECTION COMMENTS
#4	NO DAMAGE
#3	NO DAMAGE
#2	NO DAMAGE
#1	NO DAMAGE

BUNDLE IS A LOOSE FIT, INSIDE CARTON AT TEST END.

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT REINFORCED PEAS DATE: 6/2/83

TEST CARTON CODE: BC-R-H-P

DAMAGE DESCRIPTION	
CARTON	NO DAMAGE
LINER	NO DAMAGE BUT IMPRINTS OF TRAY PACK ENDS AT IMPACT END.
PADS	NO DAMAGE

TP #4	VERY SLIGHT (- .020") BULGE BUCKLE AT 1 CORNER OF IMPACT END.
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH HEAVYWEIGHT REINFORCED WATER

DATE: 6/2/83

TEST CARTON CODE: 11-BC-H-R-W

	DAMAGE DESCRIPTION
CARTON	INDENTS ON IMPACT FACE FROM DROP SLINGS.
LINER	NO DAMAGE, INDENTS FROM TRAY PACK ENDS ON IMPACT FACE INSIDE.
PADS	NO DAMAGE

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BASELINE CARTON WITH REINFORCED HEAVYWEIGHT TRAY PACKS WITH LASAGNA DATE: 6/1/83

TEST CARTON CODE: BC-RH-L

DAMAGE DESCRIPTION	
CARTON	IMPACT FACE HAS INDENTS FROM DROP SLINGS.
LINER	IMPACT FACE INSIDE BEARS INDENTS FROM TRAY PACK ENDS.
PADS	NO DAMAGE

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CARTON WITH REINFORCED HEAVYWEIGHT PEAS DATE: 6/2/83

TEST CARTON CODE: BU-R-H-P

	DAMAGE DESCRIPTION
CARTON	IMPACT END FACE HAS MARKS FROM DROP SLINGS, BOTH SIDES HAVE BUCKLES PARALLEL TO IMPACT FACE AT BOTH ENDS ABOUT 1" FROM THE END.
LINER	NO DAMAGE
PADS	CRUSHED IMPACT FACE OF IMPACT END PADS - .2". CRUSHED OPPOSITE END PADS - .1" FIBERBOARD PADS O.K.

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CONCEPT CARTON WITH REINFORCED HEAVYWEIGHT WATER DATE: 5/2/83

TEST CARTON CODE: BU-HR-W

DAMAGE DESCRIPTION	
CARTON	SLIGHT BUCKLE ON NON-IMPACT END SIDE.
LINER	NO DAMAGE
PADS	CRUSHED AS USUAL

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

ARMY TRAY PACK IMPACT TEST

TEST CARTON DESCRIPTION: BUNDLE CARTON WITH REINFORCED HEAVYWEIGHT LASAGNA DATE: 6/1/83

TEST CARTON CODE: BU-RH-L

DAMAGE DESCRIPTION	
CARTON	BOTH LONG SIDES HAVE BUCKLES PARALLEL TO IMPACT FACE ABOUT 1" FROM END AT BOTH ENDS.
LINER	NO DAMAGE
PADS	IMPACT FACE OF IMPACT END PADS CRUSHED IN .2" OPPOSITE END FACE CRUSHED IN - .1".

TP #4	NO DAMAGE
TP#3	NO DAMAGE
TP #2	NO DAMAGE
TP #1	NO DAMAGE

2. SHIPPING CONTAINER LOOSE LOAD VIBRATION TEST DATA

BASELINE CARTON TEST

Twelve cartons tested each containing four Tray Packs including:

BASELINE	HEAVYWEIGHT	REINFORCED
PEAS	PEAS	PEAS
WATER	WATER	WATER
LASAGNA	LASAGNA	LASAGNA

The cartons were subjected to 10 minutes dwell time at each resonant frequency at each orientation.

ORIENTATION	RESONANT FREQUENCIES (HERTZ)			
UPRIGHT	10	12	15	17
ON SHORT END	12	14	17	50
ON LONG SIDE	13	15	16	18

TRAY PACK DAMAGE FOUND ON POST TEST INSPECTION - NONE

BUNDLE CARTON TEST

Twelve cartons tested each containing four Tray Packs including:

BASELINE	HEAVYWEIGHT	REINFORCED
PEAS	PEAS	PEAS
WATER	PEAS	PEAS
LASAGNA	LASAGNA	LASAGNA

The cartons were subjected to 10 minutes dwell time at each resonant frequency at each orientation.

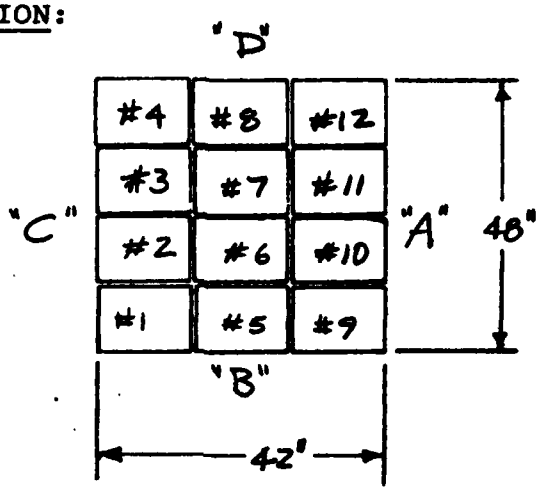
ORIENTATION	RESONANT FREQUENCIES (HERTZ)			
UPRIGHT	15.5	17.5	20	100
ON SHORT END	15.5	17.5	20	100
ON LONG SIDE	15.5	17.5	20	100

TRAY PACK DAMAGE FOUND ON POST TEST INSPECTION - NONE

3. UNIT LOAD DROP TEST DATA

UNIT LOAD TYPE: BASELINE

EDGE IDENTIFICATION:



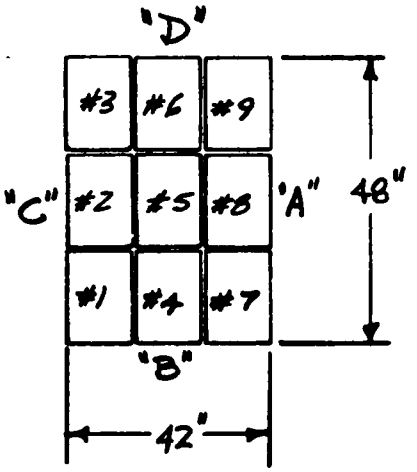
EDGE	OBSERVATIONS
6" DROP EDGE "A"	FIRST LAYER CARTONS (#19, 110, 111, 112) SIDES BUCKLED AT DROP EDGE. WHOLE STACK SHIFTED, TOP LAYER 3/4", THIRD LAYER ½" OPPOSITE DROP END, SECOND LAYER 1" AT DROP END.
6" DROP EDGE "C"	FIRST LAYER CARTONS (#11, 12, 13, 14) SIDES BUCKLED AT DROP EDGE. SECOND LAYER SHIFTED TOWARDS DROP EDGE, 1 3/4" AT "B" END AND 1" AT "D" END. SECOND (1") AND THIRD LAYERS SEPARATING IN THE CENTER "C" SIDE (½") SUCH THAT FIRST LAYER OVERHUNG BOTH ENDS.
6" DROP EDGE "B"	NO BOXES BUCKLED, SLIGHT SHIFT (¼" MAX) OF ENTIRE LOAD TO DROP END.
6" DROP EDGE "D"	1) SAME DROP HEIGHT BUT RESULTANT ANGLE LESS. 2) "A" END FIRST LAYER CARTON #112 STARTING TO BUCKLE. 3) SHOCK LESS SEVERE AS CARTONS UNDERHANG PALLET BY 2".

TRAY PACK DAMAGE FOUND DURING POST TEST INSPECTION - NONE

UNIT LOAD DROP TEST

UNIT LOAD TYPE: BUNDLE CONCEPT

EDGE IDENTIFICATION:



EDGE	OBSERVATIONS
6" DROP EDGE "A"	NO CHANGE OBSERVED.
6" DROP EDGE "C"	NO CHANGE OBSERVED.
6" DROP EDGE "D"	BOTTOM TIER END CARTONS 3 AND 9 SHORT FACES BUCKLED. CENTER CARTON #6 O.K. NO OTHER CHANGES OBSERVED.
6" DROP EDGE "B"	NO CHANGE OBSERVED.

TRAY PACK DAMAGE FOUND DURING POST TEST INSPECTION - NONE